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[*Each Author is responsible for the soundness of the opinions given, and for the accuracy of the statements made in his paper.*]

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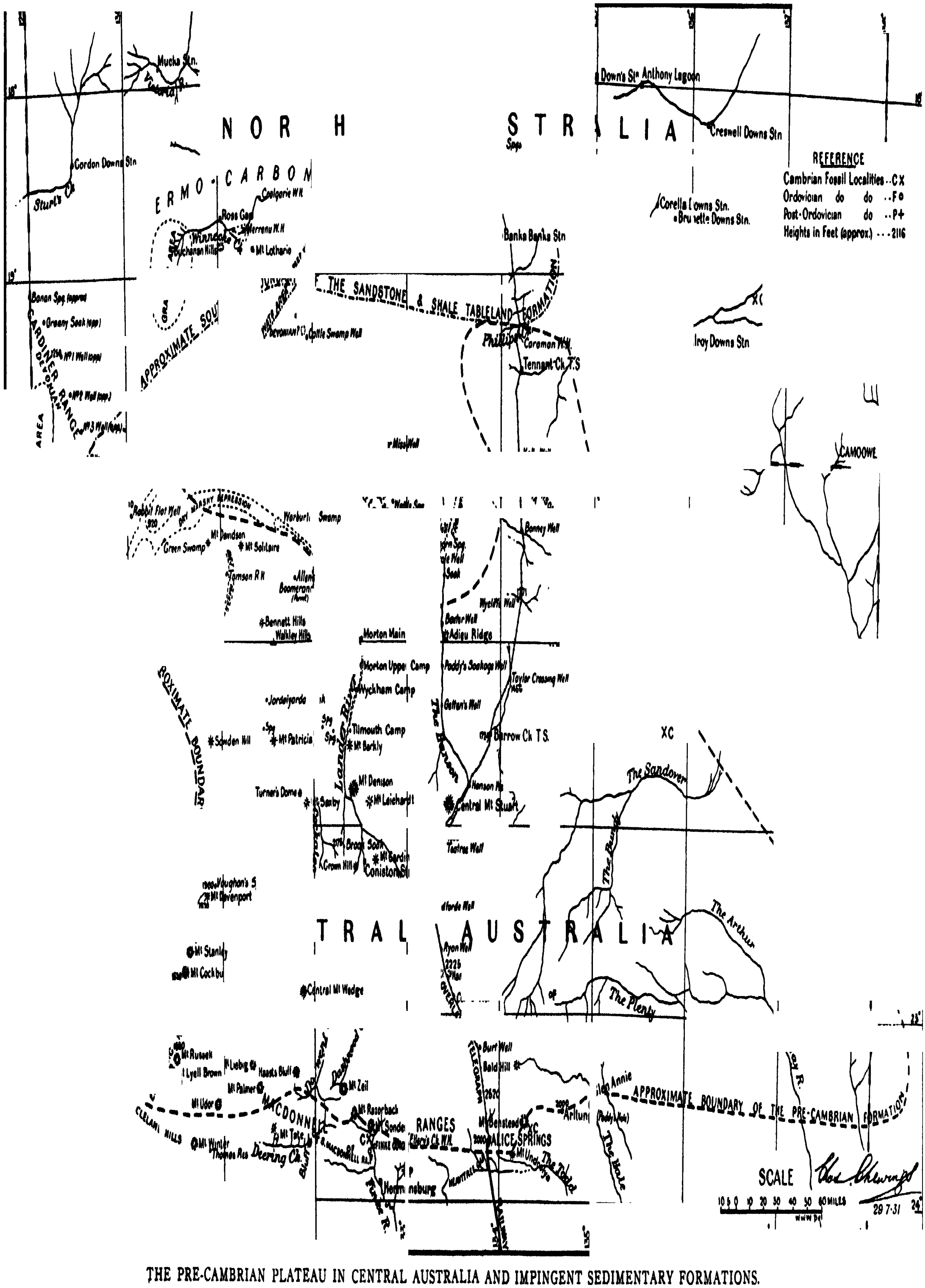

THE PRE-CAMBRIAN PLATEAU IN CENTRAL AUSTRALIA AND IMPINGENT SEDIMENTARY FORMATIONS.

Transactions

of

The Royal Society of South Australia (Incorporated)

VOL. LV.

A DELINEATION OF THE PRE-CAMBRIAN PLATEAU IN CENTRAL AND NORTH AUSTRALIA, WITH NOTES ON THE IMPINGENT SEDIMENTARY FORMATIONS.

By Charles Chewings, Ph.D., F.G.S.

[Read April 9, 1931.]

With Map.

THE ARUNTA PRE-CAMBRIAN COMPLEX.

On a former occasion the writer made reference to the Pre-Cambrian rocks of Central Australia, and the sediments thereon.(1) He now proposes to supplement those observations with a plan of the area, showing the actual contact of the Pre-Cambrians with any of the well-established sedimentaries, where known, and the "approximate" margins where the boundaries are still undefined. Many years must elapse before the true boundaries, in places, can be laid down. By reference to the map, it will be apparent that the area under consideration, and which contains some 85,000 square miles, forms the main central "boss," "shield" or plateau, or high-level region of the continent. All the major watercourses take their rise upon it. On the western and northern sides of the plateau the "fall" is sometimes not readily apparent from the short creeks, because any flood-waters are immediately swallowed up in the ubiquitous sea of sand, but the few barometrical readings available, which are on the map, will give some idea of the inclines and declines, and the heights above sea level. The height of the hills above the general level of the country is not given, but it may be mentioned that only a few mountains in Central Australia exceed two thousand feet above the surrounding plains. The elevation of the plateau is not great either, the highest portion, *viz.*, between Central Mount Wedge and Bald Hill, averages only about two thousand feet above sea level.

As pointed out in the paper above referred to, the heart, or central core of the original McDonnell Range ran east-west along, or very near to, the 23° S.L. From where the Hay River turns south (on the east) to Mount Udor (on the west) is still the main north-south water-parting—a stretch of over four hundred miles. One off-shoot from the main chain of mountains ran north-west in the direction of Tanami, and another ran north-westerly to beyond Tennant Creek. Between the extremities of these two lines lies the "Lander Depression," of which interesting feature a full description will be found in the Geographical Journal, October number, 1930, pp. 316-338. *Vide* also, *op. cit.*, p. 80.

(1) Trans. Roy. Soc. S. Austr., vol. lii., 1928, pp. 68-76. 28150/34

SEDIMENTARIES IMPINGING ON THE COMPLEX.

Some of the rock-formations that impinge upon, even if they do not actually contact with, the Pre-Cambrians of the plateau are both interesting and important in the geological record—the unravelling of which record is the principal object of this thesis. On the south margin, as is now well known to some, there runs an east-west series of sedimentary formations, all compressed together and uptilted in such a way that even skilled observers have regarded the whole as belonging to one system. By degrees the several formations are being made out, the latest contribution to the subject being a paper by Messrs. Mawson and Madigan, entitled the Pre-Ordovician Rocks of the McDonnell Ranges.[2] This paper deals with the "inside" system—the one that contacts with the Pre-Cambrians. The authors contend that between the Ordovician beds and the Pre-Cambrian rocks there runs a great series of quartzites, slates, and limestones, that are "older" than, and unconformable to, the Ordovician Series. The writer welcomes this support to his own reading.[3] The lowest beds of their Pre-Ordovician Series are quartzites, and it is these that, dipping steep to the south, contact with the Pre-Cambrians over a stretch of two hundred miles, almost continuously. The contacting quartzite is overlain by limestones containing Cryptozoon and other fossils, of probably Cambrian age. This formation is succeeded at the Finke (River) Gorge, and elsewhere, by fossiliferous quartzite and limestone beds of Ordovician age. These, in turn, are overlain by the remarkable Post-Ordovician conglomeratic sandstone series, which contain "derived" Ordovician fossils—the three formations, placed as they are, are a very interesting study, and the person who can determine the age of the conglomerate beds will assist the geological record greatly.

As Messrs. Mawson and Madigan's paper was presented in London, it may be of interest here to observe that they therein suggest aboriginal names for the more important groups. The writer considers the suggestion a useful and happy one, but would slightly alter the spelling of some of the names suggested by them to the following, and also add No. 4 to the list:—

1. Arunta Complex = the Pre-Cambrians.
2A. Pertaknurra Series = the inner (lower) quartzites, slates, and limestones (7,500 feet thick) = Pre-Ordovician or Cambrian (?).
2B. Pertaoorta Series = quartzites, slates, limestones (2,850 feet thick) = Pre-Ordovician or Cambrian (?).
3. Pertakooka = Larapintine in part of Tate and Watt = Ordovician.
4. Pertnjara = the Post-Ordovician Conglomeratic-Sandstone Formation.

NOTE.—1. = the name of the local tribe; 2A. = the big range; 2B. = limestone; 3. = small range; 4. = many stones (range).

At the head of the Finke and westward to where the ranges fall off, the northern, and higher, portion—which is known on the spot as the McDonnell Ranges—embraces, in a general way, Nos. 1 and 2A; and the "South" McDonnell, Nos. 2B, 3 and 4. Where the South McDonnell ends, *viz.*, a short distance west of Mount Tate, the Cambrians have either been completely eroded, or faulted out of sight, but south of Mount Tate the Ordovician sandstones of Gardiner's Range, with thin bands of fossiliferous limestone interlarded, still run on westward, in the form of an anticlinal fold. The strike of the anticline is a few degrees north of west, in which direction it becomes covered with sand, but soon rises again and forms the Cleland Hills and other sandstone ridges farther on in the same direction. Lithologically these Ordovician sandstones bear little or no resemblance to the Cambrians, and are far less disturbed than the older series. These latter being absent along that portion of the line lying north of Mount Winter and

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(2) Abstr. Proc. Geo. Soc. of London, No. 1,209, 1930, p. 56.

(3) Trans. Roy. Soc. S. Austr., vol. lii., 1928, pp. 63-68 and 76-78.

Thomas Reservoir, and south of the Ehrenberg Ranges, doubtless the contact is with Ordovician rocks, and apparently identical conditions continue around to the west of Mounts Lyell Brown, and Cockburn.

One may here remark that the McDonnell Ranges, as a bold feature, ends in the prominent peak of Mount Liebig, but the Pre-Cambrians extend far to the west of that mount, to beyond the Ehrenberg Ranges; and they apparently extend westward an equal distance in the western end of the Treuer Range. As far north as the 22°, or perhaps even to the 21° S.L., the writer thinks Ordovician rocks may form the contact with the Cambrians, but wind-blown sand appears to cover everything along that stretch. From Treuer Range the elevation decreases, going north. Somewhere hereabout two other rock formations seem likely to put in an appearance, for they are in evidence farther north, and also farther west. One will be referred to hereafter as "Winnecke Creek Tableland Formation" (which is of Permo-Carboniferous age). The other is Devonian. The former, according to W. H. B. Talbot,[4] who mapped the area, extends from Gardiner's Range, and Tanami, to Hall's Creek, and from there south-westerly along the Canning Track to 23° S.L. Over the whole of that area this formation appears to have suffered much from erosion, but very little from earth movements, since it was laid down. With the exception of island-like areas more elevated than that on which it occurs, the formation apparently covered the whole area between Treuer Range and Derby. This fact, coupled with another, *viz.*, that *so far as is at present known it was the last formation to be deposited* on the north and north-western slopes of the plateau, renders it of great interest. The strata are composed of conglomerate, grit, shale, and sandstone, often highly ferruginous, and coloured chocolate brown on exposed faces. No limestone beds were observed in the strata along the Canning Track. A considerable extension of this formation, in an eastward direction from Tanami, beyond Talbot's boundaries will be referred to later on. In the Tanami (Gardiner's Range) district, both Permo-Carboniferous and Devonian appear to contact with the Pre-Cambrian.

Along the Canning Track, where the Permo-Carboniferous formation ends, *viz.*, near the No. 26 well (which lies a little north of 23° S.L.), rocks of Devonian age occur, and the area between No. 26 well and 25°-30° S.L. Talbot has mapped as Devonian—with the *eastern boundary* of that formation still undefined. The strata are there composed of sandstones, quartzites, shales, grits and conglomerates. Exposures, all over the area seen by Talbot, showed that the formation (unlike the Permo-Carboniferous beds) had undergone considerable disturbance, as well as vast erosion. The dips varied greatly, up to 65° The strike varied greatly also. Faults also were numerous in the formation which, in that district, reposes on granite and metamorphic rocks.

Judging from Talbot's determinations, it seems probable that Devonian rocks at one time occupied the area between No. 26 well and Hall's Creek, and eastward to Tanami, and probably far beyond that. The Albert Edward Range (near Flora Valley Station), in the Kimberley District, is composed of rocks of Devonian age. In that range, according to Talbot, the Devonians repose on metamorphic rocks and, in turn, are overlain by the Permo-Carboniferous formation. Gardiner's Range is situated north-west of, and is near to, Tanami. Talbot recognised it as of Devonian age, and mapped it as such, with Permo-Carboniferous rocks overlying to the west and north. He refrained from expressing an opinion on, or even colouring, any part over the border, *i.e.*, in the Northern Territory, but Mr. H. Y. L. Brown's description and map [5] show the Permo-Carboniferous formation to

(4) W.A. Geolog. Survey. Bulletin, No. 39.

(5) H. Y. L. Brown, Tanami Gold Country. Parlty. Paper, Adelaide, 1909, p. 7, *et seq.*

extend north-easterly to near the Mucka Outstation, on the Victoria River. Mr. Brown, however, did not separate the Devonian from the Carboniferous, and referred to the two as "sandstone, grit, quartzite, and conglomerate of the table-hills and tablelands," and as "Primary rocks." Mr. Allan Davidson, the discoverer of Tanami, also mapped the two formations as one, and set the age down as "Secondary." (6) He shows the formation, which he maps as Secondary, and Talbot as Carboniferous, to extend eastward to the Buchanan Hills but, strange to say! he did not colour the Winnecke Creek exposures at all, although he walked over many scores of miles of the formation (Permo-Carboniferous). It is to Talbot we owe the discovery that both Devonian and Permo-Carboniferous rocks contact with the Pre-Cambrians in the Tanami sector; the latter only, of course, where the former had been completely eroded away prior to the deposition of the latter.

Some Remarkable Devonian (?) Remnants.

And here it seems opportune to mention that, originally the Devonian formation assumed a greater elevation around the great Cenfral Plateau than ever the Permo-Carboniferous did and, consequently, ascended the slopes much farther. Great erosion had taken place over the plateau prior to the laying down of the Devonian formation, and, of course, all other sedimentaries had been removed from areas where it reposes on the Pre-Cambrians. From Davidson's descriptions one cannot doubt that the Pre-Cambrians were covered prior to the Devonian epoch by still older sedimentaries all the way between Tanami and Barrow Creek, along the line he returned by to the telegraph line. Although the principal orographical disturbances may have gone by—and probably they had—it is, nevertheless, certain that the Devonian formation was in existence during the latter stages of the mountain-building period, for everywhere the remnants show unmistakable evidence of, if only slight, uplifting and disturbance. Talbot observed one case where quartz reefs were present in the bedding planes. This was on a partially-eroded anticlinal arch—but, taken as a whole, the Devonian rocks appear to show little, or none, of the ordinary metamorphic characteristics of the oldest sedimentaries; at any rate around the Central Plateau. The formation is seen to be greatly eroded, except in protected areas, or where the component rock happened to be of exceptionally durable character, or where protected by a durable covering. Over large tracts of country the formation, notwithstanding its original massive character, is now represented only by remnants.

The following allocations must be taken as "suggestive" only in an effort to "place" the age of certain well-known remnants occurring in Central Australia. *First:* The writer suggests that the Post-Ordovician Conglomeratic-sandstone formation, of the Finke River,(7) may be of Devonian age. *Second:* Judging from John McDouall Stuart's description, Mounts Denison, Leichardt, and Barkly, of the Lander Creek, (8) may be Devonian. *Third:* Mounts Palmer, Crawford, Peculiar, and Udor, (9) at the western end of the McDonnell Ranges, may be of Devonian age. *Fourth:* Ayer's Rock, Mt. Olga, and Mt. Currie, in the Lake Amadeus Valley. As these three very remarkable remnants have been regarded by some geologists as belonging to some far older rock-formation than the Devonian, it may be advisable to examine the evidence we have to ascertain whether such opinions were justified. To this end, and to make my reasons more easily understood, it seems requisite to postulate that: Two long lines of granitic rocks formed the main orographical features of Central Australia in Early Palaeozoic times. Remnants show that the two lines—they were then high mountain ranges—maintained a rough parallelism to one another. The two lines of

(6) Allan Davidson, Explorations in Central Australia. Parlty. Paper, Adelaide, No. 27, 1901.

(7), (8), and (9) Trans. Roy. Soc. S. Austr., vol. lii., 1928, pp.: (7) 76-77, (8) 80-81, (9) 78-79.

ranges were separated by a low-lying tract of country, 150 miles across. Both lines ran east-west in the eastern half of their courses, and west-north-west in their western halves. We will call the northern line "The McDonnell Line," and the southern one "The Musgrave-Petermann Line." The earliest sedimentation we have to do with, in this connection, is the one that now is represented by the quartzite cappings of many of the northernmost granite and gneiss hills of the Musgrave-Petermann line. These latter lie south of, but apparently do not approach, the line of conglomerates nearer than 20, or more, miles. As the quartzites dip north, and as the conglomerates stand well out in the Lake Amadeus Valley, the ground on which the conglomerate beds repose, and the intervening space between them and the quartzite cappings, almost for a certainty, is occupied by the up-turned edges of strata that originally formed the flanking beds of the range—in the way the South-McDonnell sedimentaries do today; the dips of the said strata increasing in the underlying beds as they approach the site of the old, but long since denuded, range. (It will be shown later on that the quartzite beds do actually underlie the conglomerate, but exposures are rare in that sandy region.)

Similar quartzite beds overlie, and contact with, the Pre-Cambrians in the McDonnell line. The formation to which they—the quartzite beds—as represented by the cappings—in the Musgrave line belong is covered by younger sedimentaries, or sand all the way to the McDonnell—150 miles. Ordovician strata are very much in evidence over the stretch between the two lines, as the following will show. First we have the Gardiner's Range anticline that lies near to, and south of, the McDonnell. This anticline is fossiliferous. The next (omitting the short anticline near Temple Downs old station) is George Gill's Range anticline. This also contains Ordovician fossils. Then follow on sundry outcrops of, lithologically, identical rocks that occur sporadically in the sandy country between George Gill's Range and Lake Amadeus. These show that the folds follow on, but decrease in intensity the farther away they get from the ranges. Between Lake Amadeus and the conglomerate beds no outcrops have been noted above the sand, but *on* the conglomerate line, *viz.*, to the east of Mt. Olga, there is an outcrop of quartzite that dips north at 55°, and strikes south 75° west. The strata-dip here is to the *north,* and fairly steep, which indicates that the quartzite strata belong to one of the formations that flanked the Musgrave-Petermann line of ranges. Mr. Frank George, in referring to the quartzite outcrops and cappings seen by him in the Mt. Olga area, states: (10) "It again occurs east from the Mt. Olga group of hills, where it has a thickness of about 300 feet, strikes south 75° west, and dips north at an angle of 55°, *and appears to be overlain by the Mount Olga boulder conglomerate beds*, but the line of contact between the two formations being covered with sand their relative positions cannot be definitely ascertained. The conglomerate contains boulders of similar quartzite. Mount Connor, an isolated flat-topped hill to the eastward, is capped by similar quartzite having a thickness of over 300 feet. Mount Olga Range consists of about thirty immense dome-like masses of boulder and pebble conglomerate. The contained boulders are waterworn and smooth, and with the exception of a little quartzite consist wholly of granite and eruptive rocks, the boulders varying in size from 2′ x 1′ x 6″ down to pebbles the size of peas. A rough semblance to stratification is observable in this conglomerate bed; the layers of boulders lie in parallel planes, having a dip westward of from 10° to 15°."

In the Journal of the Horn Scientific Exploration to Central Australia (11) there is a good photograph of some of the hills in the Mt. Olga Range, which

(10) Wells and George, Prospecting Operations. Parlty. Paper, Adelaide, No. 54, 1904, pp. 6-7.

(11) Horn Expedition. Parlty. Paper, Adelaide, No. 19, 1896, p. 28.

shows the bedding planes very clearly and, as stated by Mr. George, are nearly horizontal. It follows therefrom that the conglomerate beds repose unconformably upon a sedimentary formation of greater age. J. A. Watt, a geologist in the Horn Expedition (*op. cit.*) remarks: "Mt. Olga appears to be composed of a coarse conglomerate from top to bottom, which consists, for the most part, of pebbles of granite and other eruptive rocks (*vide* also No. 1 reference, p. 8, for a list of some of the rocks)." W. R. Murray [12] measured the height of Mt. Olga, *viz.*, 1,420 feet above the plain, and states that "some of the pebbles would weigh several hundredweight," and that "the summit appears to be quite inaccessible." Of Mt. Currie he states: "The formation is the same conglomerate as Mt. Olga." The Mt. Currie Range is not so high as the Mt. Olga; it lies a few miles to the north-west of the latter, and is a remnant of the same conglomerate formation.

Before quitting this conglomerate formation—the outcrops of which occur at intervals, in lineal arrangement, for 50 or 60 miles—some reference to Ayer's Rock must be made. It lies 15 miles east of Mt. Olga. Watt states (*op. cit.*) that: "Ayer's Rock is very indurated, and to some extent, *altered arkose sandstone*, decidedly gritty in parts." "The original sedimentary character of it is unmistakable." Smooth, rounded pebbles of quartz and felspar are visible in hand specimens. It has been to some extent altered by metamorphic agencies. It stands about 1,100 feet above the plain. The sides ascend, in places, quite vertically for 500 to 600 feet. A peculiar netted appearance is to be seen in some of the faces, due to the irregular weathering of the rock. A ridging is observable, which probably indicates the direction of foliation planes trending in a N.W. and S.E. direction." George states (*op. cit.*): "Ayer's Rock consists of metamorphic pebble and grit conglomerate. The pebbles are sub-angular, and vary in size from that of an almond to coarse sand. "They consist of felspar and quartz, but chiefly felspar."

A reproduction of a recent photograph of a portion of Ayer's Rock that appeared in *The Register* newspaper, Adelaide, of November 11, 1930, shows the strata in Ayer's Rock to lie near the horizontal.

It is evident that these remnants—Ayer's Rock, Mount Olga and Mount Currie—represent quite a massive and important formation. The conglomerate evidently is the detrital matter from an elevated and vast area of plutonic rocks that, at the time the conglomerate beds were formed, stood thousands of feet higher than the top of Mount Olga. The mountainous area had, even at that early period, reached a stage in its denudation when the Pre-Cambrians supplied the greater proportion of the conglomerate, in the form of boulders of granite and other deep-seated rocks. It was a very old range when the conglomerate beds were laid down, and the end of the great earth movements was approaching. This is evident from the nearly horizontal disposition of the Mount Olga conglomerate strata; and the absence of extensive jointing, uptilting and fractures in Ayer's Rock points in the same direction. Much jointing and fracturing is a feature of all Pre-Ordovician rocks in Central Australia. The writer regards Watt's suggestion, *viz.*, that the "ridging" which probably indicates the direction of foliation planes in Ayer's Rock as untenable. The disposition of the underlying sedimentaries, and also the bedding planes in the Mount Olga Range and Ayer's Rock, nullify the possibility of horizontal pressure of such magnitude, so late in the day—in the tectonics record of that portion of Central Australia. It is possible these conglomerate beds belong to the Ordovician formation, but lithologically they bear no resemblance to it; they do not antecede it in age. It bears closer resemblance to the Post-Ordovician formation, as seen in the South McDonnell Range, although in several respects the two are not analogous. The incipient metamorphism, and the semi-sphaerical exfoliation habit of weathering of Ayer's

(12) R. T. Maurice, Explorations. Parlty. Paper, Adelaide, 1904, pp. 30-31.

Rock, have little bearing on the point at issue. The writer thinks the South McDonnell and the Mount Olga lines of conglomerate may have been formed under somewhat similar conditions as regards situation, climatic conditions, and time, which may have been Devonian time.

But to return to the delineation of the Pre-Cambrian area: From Tanami the line runs south of east for many miles; and along this stretch recent sand-plains and sandhills completely hide from view the contacting rocks. Similar conditions prevail where the line turns and runs north again, to a point situated about twenty miles north of Tennant's Creek, where it again strikes the Winnecke Creek Tableland formation. This formation, which we last saw at Tanami, here forms the southern side of the low line of ranges, over which the telegraph line runs from the spot indicated to beyond Powell's Creek—120 miles. North of that the range is known as "the Ashburton." The point referred to is the low hill the telegraph line crosses two or three miles south of the Caraman waterhole, or swamp. In the Caraman, or Phillip's Creek valley an older series of rocks is seen.

TENNANT'S CREEK TO NEWCASTLE WATERS.

Going north from the Phillip's Creek, the Winnecke Creek formation is well developed, and is there, as elsewhere, composed of alternating beds of shale and sandstone, both being ferruginous, and of chocolate-brown colour. The sandstone strata are often flaggy. The beds undulate, with maximum dips of 10° or 15°. It should, perhaps, be stated here that the Winnecke Creek formation formerly formed a continuous sheet from near Tennant's Creek to Newcastle Waters, but that it now occurs only as large remnants—some of which stretch for several miles—but always is seen to occur as the uppermost rock formation of a partially-eroded tableland that extends west of the telegraph line.

Principally through fluvial erosion into its eastern escarpment, an older and more highly disturbed sedimentary formation than the above is exposed in many of the valleys and lowlands lying between Newcastle Waters and Tennant's Creek. These exposures are probably the southerly extension of the rocks of the Ashburton Range. On the watershed, a few miles south of Attack Creek, quartz veins traverse these older sendimentaries. At other exposures quartz rubble bestrews the surface. In places the rocks are upheaved to near the vertical. The strike is commonly north-north-west, but varies greatly in places from that direction. For the most part the strata of this formation, as seen along the telegraph line, are of quartzite and sandstone. As a suggestion only: the formation may be a continuation of the rocks underlying the Barkly Tablelands, in which, farther to the south-east, H. Y. L. Brown discovered Cambrian fossils, in limestone, from a well near the Alexandra Station, on the Barkly Tableland.

Typical examples of the Winnecke Creek Tableland formation occur in many places on the overland telegraph line. One is, the stretch over the tableland between Renner Springs and Banka Banka Station; and another, from 10 miles south of Attack Creek to Phillip's Creek. The "older series," before noted, may be seen at Banka Banka Station, Powell Creek, and at many other places. As a rule these latter are highly tilted, and show marked evidence of considerable disturbance. In places they enclose quartz veins. There is little lithological similarity between the two formations. There is, of course, a strong unconformity between them.

From the telegraph line, at the point before mentioned and situated twenty miles north of Tennant's Creek, the Pre-Cambrian line of contact apparently is with the Winnecke Creek Tableland formation as it runs east, but only for a few miles. It then turns south around a granite area for 20 miles, and then follows a south-easterly course along the north-eastern side of the granites, schists, and metamorphic slates that are exposed on the eastern side of the Murchison Ranges,

to 20° S.L. Along this stretch the Cambrian (?) rocks of the Barkly Tableland would appear to be the contacting series—as they are in the Murchison Ranges. There is uncertainty here, however, for over most of the distance the alluvial and sandy flats hide the actual contact. Still on south-easterly, the line passes near where Davidson discovered Cambrian fossils, in rocks that form the south-east extension of the Murchison and Davenport Ranges, at about 21°, 30′, S.L. How far south-east of that point one may assume the contact to be with the Cambrians is difficult to say. Very little is known of the south-eastern portion of the Pre-Cambrian area, and less is known about the age of the contacting rocks. When nearing Glen Annie the Cambrians take up the running, and continue the contact right to starting point. Away east of Glen Annie it is possible the Ordovicians are in contact, for that formation is reported to be well represented there.

NOTE.—Since this paper was written an interesting discovery of probably Ordovician fossils was made by Mr. N. B. Tindale, the Ethnologist of the Adelaide Museum. The fossils are in the forms of casts, in a quartzite matrix. One represents a species of *Orthoceras*, and another a species of *Raphistoma*. These closely resemble the Ordovician fossils of the Finke River region. The locality is a range of hills between the sources of the Plenty and the Sandover, that lies about 100 miles north-north-east of Arltunga. The range stands on the eastern slope of the Pre-Cambrian Plateau. Mr. Tindale's section indicates that the fossiliferous beds dip at a low angle to the north-east, and the formation, of which they form a part, reposes unconformably upon a still older and more highly disturbed sedimentary series which contacts with the Pre-Cambrian schists. The discovery is important, because it shows that the Ordovician formation originally had extensive development on the eastern slopes of the plateau. Our previous certain knowledge of it in Central Australia was largely confined to the southern slope. The order of succession of the three formations apparently correspond in both localities. North-east of Tindale's discovery, Davidson found Cambrian Trilobites in the lower sedimentary series.

THE WINNECKE CREEK TABLELAND FORMATION.

The writer's first acquaintance with this widespread formation was when opening up a line of waters between Barrow Creek and Victoria River, in 1909. When nearing 19° S.L. the sandhill country abruptly changed to a dark chocolate-brown colour, with firm ground bestrewn with ironstone pebbles. First a rise and then a descent into a "valley of erosion" were encountered. The descent was abrupt into this trough-shaped depression, which ran in a north-south direction. It proved to be an ancient watercourse, with a level, grass-covered bottom. Ferruginous sandstone, horizontally disposed, and occurring in layers, could, with some difficulty, be traced along the sides of the valley, and fragments of shale bestrewed the surface in places, indicating the presence of shale beds as well as sandstone. This formation was afterwards found to extend to Winnecke Creek, and from there on to Victoria River, in gentle undulations all the way. The wide depression in which Winnecke Creek runs is a similar "trough" to the one first mentioned, but much larger. Both are fluvially-eroded channels of considerable antiquity. The Camfield River is one of the large eastern tributaries of Victoria River. From Winnecke Creek to the Camfield this formation is one continuous sheet, with the exception of a small island-like exposure, of three or four square miles in extent, the rocks of which are slates and limestones, highly tilted in places and much disturbed. Quartz pebbles bestrew the surface of this small area, which lies fifty miles south-east of the Wave Hill Station.

Considerable areas of basalt are exposed in the Camfield River country. Some of the basalt hills there stand well above the level of the tableland formation, from which the latter has been eroded well back—erosion seeming to have taken hold of the ruptured state of the tableland formation around the volcanic necks.

The tableland formation extends from near the Mucka Outstation, on Victoria River, to south of Buchanan Hills without a break. The most easterly of any isolated hills of this formation, seen by the writer in the Winnecke Creek

district, is the solitary pinnacle—Lothario Hill—situated some 25 miles east of Buchanan Hills. The hills owe their preservation to an indurated capping, and represent the more easily erodable upper beds, of sandstone, of this formation. The lower beds of shale and conglomeratic sandstone being more resistant, extend over vast areas. Its occurrence on the overland telegraph line has already been noted. Notwithstanding that the writer has not travelled over all the country lying between Winnecke Creek and the overland telegraph line upon the formation, he is quite satisfied, from its mode of occurrence in both localities, and the lithological similarity everywhere seen, that formerly (if not at present) the Winnecke Creek Tableland formation covered the area between those districts.

Good sections of this formation may be seen at Ross Gap, and on the steeper sides of the Winnecke Creek valley, a few miles below that spot. At the Gap there is much ironstone. On either side of the creek, at the Gap, are small, low hills of ironstone, that run back from the creek a mile or two. Buchanan Hills are the most easterly of a number of flat-topped hills that occur in the Tanami region, at the head of Winnecke Creek, and around the Gardiner's Range, and, as set out earlier in this thesis, Talbot carries these hills and the formation well on towards Wiluna, in Western Australia. He regards its age as Carboniferous, *i.e.*, Permo-Carboniferous, and maps it as such. The writer now extends its area from Tanami to the overland telegraph line, over the country lying between 17°, 30′, S.L, and 19°, 30′, S.L., or, in other words, between Tennant's Creek and Newcastle Waters.

In places in the valley of the Victoria River and its tributaries a still older, and considerably disturbed, sedimentary rock formation occurs. It is composed of limestones, shales, sandstones, quartzite, etc., that may, judging from Talbot's descriptions of rocks of that age that occur over the Western Australian border, be of Devonian age. The most southerly exposures of the basalt in the Victoria River area, seen by the writer, extended from Mucka Outstation east to a few miles beyond the big south-east bend of Victoria River. In no case, notwithstanding that the tableland formation covers such extensive areas of country, did it appear to have had any very great vertical dimensions. The soil derived therefrom is very poor in comparison with that from the basalt in the Victoria River district.

A NORTH-SOUTH CORRELATION.

Judging from Talbot's map and descriptions as set out in the bulletin mentioned above, and also from what may be gathered from the explorer's journals —which, unfortunately, is very meagre—it may reasonably be inferred that the Devonian formation, as typified in the Gardiner's Range at Tanami, has its counterparts in at least some of the remnants extant on the slopes leading off the plateau. A few of these remnants, as would appear to answer to the requirements, have already been mentioned. Should those selected, or any of them, meet the case, the important fact would be established that the Devonian formation was well represented on both the lower and higher slopes of the plateau. Such a discovery would elucidate many points now inexplicable, or, at any rate, litigious. On the northern slopes of the plateau such remnants are perhaps more likely to be found in the broad, ancient valleys of the Hanson and Lander Creeks under the lee of former high ranges. Mounts Barkly, Denison, and Leichardt appear to be located in favourable situations. The writer has experienced doubts as to which formation Central Mount Stuart and other hills in that neighbourhood belong, but, unfortunately, has never had the opportunity of verification, notwithstanding that he has passed through that part many times. On the southern slopes of the plateau lies the Post-Ordovician sandstone-conglomerate formation, before referred to, which is situated in a "protected area," and might very well be of Devonian age.

On the southern slopes erosion had already removed a large, if not the greater, portion of the massive Post-Ordovician formation prior to the deposition of the next succeeding sedimentation of which we are cognisant. Over large areas, and in different localities, these "Post-Post-Ordovician" beds, or Finke River Series, repose on Ordovician, or rocks of still greater age. The writer has satisfied himself that the conglomerate beds in the Finke River Series, near Crown Point, and which for the most part are composed of quartzite pebbles and boulders, were largely "derived" from the Post-Ordovician conglomerate beds that are so well developed in the South McDonnell Ranges. David and Howchin regard the Finke River Series as of Permo-Carboniferous age. It is certainly younger than the Post-Ordovician, for it is known to repose, unconformably, upon it. Lithologically the two are most unlike. The Post-Ordovician beds undulate, while the Finke River Series lie very near the horizontal. The former, in the Finke River region, attain a greater elevation than the latter. Originally a thousand feet or more.

As regards disposition (*viz.*, lying near the horizontal) and lithological similarity (*viz.*, sandstone overlying shale beds), the formation is similar over very wide areas. We have the Finke River Series on the southern slopes, and the Tanami to overland telegraph line Permo-Carboniferous beds on the northern slopes, with a great extension of the same formation towards Wiluna, and to Derby on the west coast.[13] H. Y. L. Brown also noted the same formation in different places on the north coast, all of which go to show how widespread the formation is in Australia.

There appears to be no reason to doubt that the whole belongs to, or originated in, one contemporaneous sedimentation, and from the evidence we have the following epitome may be deduced:—

(*a*) The plateau, as an elevated tract of land, was in existence, and its present form and features, in a general way, had been determined before Permo-Carboniferous sedimentation.

(*b*) Only remnants of the Post-Ordovician series remained on the plateau slopes during the Permo-Carboniferous sedimentation, but they show that the latter never reached the vertical elevation of the former by at least a thousand feet.

(*c*) The plateau has been a "fairly stable region" from early Permo-Carboniferous times to the present, and similar stable conditions appear to have obtained over much of the western two-thirds of the continent during the same time.

(*d*) The Permo-Carboniferous strata that covered the higher southern slopes of the plateau, together with practically the whole of the area covered by that formation lying to the north and west of the plateau area as well, show no indications of ever having been covered by any later marine sedimentation. Sub-aerial conditions appear to have persisted over the area through all subsequent time. The lower beds indicate sub-aqueous still-water conditions during their formation, but the frequent occurrence of long, thin lenses of pebbles and small boulders in the middle and upper beds that occur on both the north and south sides of the plateau indicate shallow water conditions, while sub-aerial and even Arctic glacial conditions obtained during the formation of the upper beds on the Finke. The interleaved long lenses of haematite and limonite point to lacustrine conditions. Heavy ironstone bands are a conspicuous feature in the Winnecke Creek area.

[13] Natural Regions in W.A., by E. de C. Clarke. Jour. Roy. Soc. of W.A., vol. xii., pp. 117-132.

(e) The upper Permo-Carboniferous beds are extremely pourous, and it is they that form the intake, and the water channel, beds of the Lake Eyre artesian basin around its north-western rim. These porous beds are very favourably situated, as regards elevation, to catch the rainwaters that drain off the eastern and southern slopes of the plateau. The rain that falls on sandy areas that cover the intake beds probably augments the supply also. Sinking immediately into the sand it doubtless percolates to the intake beds. The bore at the Finke railway crossing probably indicates the horizon at which the sub-artesian supplies are standing in the intake beds on the Finke. In north and north-west Australia, over very large areas, this formation, as just stated, appears not to have been covered by any younger sedimentation, but off the east and south-east sides of the plateau the beds plunge into the Lake Eyre basin, and are there known to be covered in places by over 5,000 feet thick of superincumbent Mesozoic and Tertiary strata.

In ascending order, the sedimentary formations known to the writer to have either partially or wholly covered the plateau are as follows:—

(1) *The Pre-Cambrian Complex*—the foundation rocks of Central and North Australia—are of, apparently, both igneous and sedimentary origin. Proterozoic.

(2) *Cambrian*—Certain localities yield *Cryptozoön,* and others *Agnostus, Microdiscus* and *Olenellus*, trilobite fossils.

(3) *Ordovician.*—Various spp. of trilobites and other characteristic fossils of that age occur in many places, and over wide areas.

(4) *Post-Ordovician—Devonian (?)*—A massive formation, reduced greatly by denudation, that is characterised by quite phenomenal accumulations of conglomerate. Only "derived" Ordovician fossils discovered to date.

(5) *Permo-Carboniferous.*—The age of this formation has been arrived at by tracing the extension of beds of determined age, on the north, and by analogy of those occurring on the south side of the plateau.

NOTE.—*The Jurassic, Cretaceous, and Tertiary* formations of the Lake Eyre region appear not to have ascended the slopes sufficiently far to leave remnants on, or impinging on the plateau.

ADELAIDE UNIVERSITY FIELD ANTHROPOLOGY, CENTRAL AUSTRALIA.

No. 8.—A TABLE SHOWING THE CLASS RELATIONS OF THE ARANDA.

By H. K. Fry, B.Sc., M.B.B.S. (Adel.), B.Sc., D.P.H., Dipl. Anth. (Oxon.).

[Read May 14, 1931.]

One of the most interesting features of the Australian Aboriginal is the social organisation of the tribes into classes which regulate marriages. These arrangements are clear cut and precise to the natives, even the small children can state at once the class to which all their acquaintances belong, and what relation tribally they bear one to another. But when an enquiring mind is brought to bear on the matter, the problem soon develops into such a complicated maze that interest is apt to cool off in this direction and become diverted into less bewildering fields of study.

The Aranda are the type example of an eight-class nation. The Table I. presented here gives a compact picture of the mutual relations of these eight classes. It undoubtedly appears complicated at first glance, but it so happens that it works out on such unexpectedly simple geometrical lines, that I venture to think that, in helping to visualise the intricacies of the complex problem, it elucidates a difficult subject.

The scheme of the table was worked out during the visit of the Adelaide University Anthropological Expedition to Hermansberg in August, 1929, carried out with the aid of a grant from the Australian National Research Council.

The spelling of the class names is that of Strehlow. Males of the various classes are indicated by the class names printed in small type, females are shown by the names printed in large type, *e.g.*, Pananka for the male, PANANKA for the female. The names fall into alternate horizontal rows of four males and four females. Lines of four varieties are used, each showing a constant relation to a pair of male names. The thick and thin continuous lines are in relation to males of "A" moiety, thick and thin dotted lines to males of "B" moiety. The vertical portions of the lines represent direct male and direct female descent. The horizontal portions of the lines linking the vertical portions of corresponding character, indicate a marriage union, thereby linking husband and wife above as parents, and brother and sister below as children. For example, Panaka marries PURULA, and their children are Bangata and BANGATA; BANGATA is married to Mbitjana, and their children are NGALA and Ngala.

The right and left margins of the table are to be considered as contiguous, as would be the case actually if the diagram were mounted on a vertical cylinder. Consequently, a line ending free on one margin is to be read as continuous with the free end of the corresponding line at the opposing margin.

The bottom line is a replica of the top line. The names, of course, represent different individuals in a genealogical table, but are identical from a class relation point of view. Therefore, the table could also be mounted on a horizontal cylinder, and its general form is that of the surface of a solid ring.

For working purposes the plane presentation is more simple and the diagram can be extended, if necessary, by repetition in all directions.

An inspection of the table shows the males in four vertical lines, each with two alternating names of the same moiety. The females fall into four vertical lines of alternating moiety, the first and third lines containing the same four names, and the second and fourth the other four. In these paired lines, female names alternate in pairs.

The third row shows the same actual marriage linkages as the top row; the fourth the same as the second.

The lightly drawn linear system, as a whole, is a replica of the linear system in heavy lines. The dotted line system is a mirror image of the continuous line system displaced one generation.

The "A" and "B" moiety names can be transposed without altering the form of the diagram.

The table, therefore, shows the inherent regularity of form which is demanded of it by the nature of the problem which it is intended to illustrate.

The table can also be drawn up in a generalised form, so that the appropriate class names of any eight-class tribe can be applied to it. This is indicated by the lettering above the class names, where a1′, a1″, a2′, a2″ represent males of the four subclasses of "A" moiety, b1′ b1″, b2′, b2″ males of "B" moiety, arranged as in the diagram according to their marriage relationships. A1′, A2″, A2′, A2″, B1′, B1″, B2′ B2″ similarly represent females of their respective moieties.

It will now be seen that the group (a1′, A1′, b1′, B1′, a2′, A2′, b2′, B2′) is correlated with the thick line system, and the group (a1″, A1″, b1″, B1″, a2″, A2″, b2″, B2″) with the thin line system. There are many tribes such as the Southern Aranda and the Warrai which have a four-class nomenclature with an eight-class organisation. Each class name, therefore, covers two subdivisions which are stated to bear the mutual relation of "ipmunna"(1) to one another. These are represented by the a1′ and a1″ groups (thick and thin line, respectively) mentioned above.

If the Aranda table be compared with Table II., in which the class names of a typical four-class tribe, the Kariera, are tabulated by a similar representation of marriage and descent, it will be seen that the eight-class table represents a quadruplication of a four-class diagram, by a duplication of class names (ipmunnas) and a change from a two-generation to a four-generation cycle. The complexity of the linkage lines of the eight-class table is due to the interchange of the female ipmunnas A1′ and A1″, B1′ and B1″, A2′ and A2″, and B2′ and B2″, in the third and fourth generations as compared with the first and second generations.

If the class names of a two-division tribe such as the Warrunjerri be charted on the same plan as above, it will be found that the pattern of the four-class diagram is reproduced.

So far tribes of paternal descent only have been considered. In the case of tribes of two moieties or four classes, such as the Urabunna and Kamilaroi, respectively, in which maternal descent is the custom, the four-class diagram will be found to hold good if the a1, A1, etc., terms be transposed so that the male vertical lines then show the alternation of moiety in succeeding generations.

No instance is known of a fully-fledged eight-class system with maternal descent, but the table would work out equally well for maternal descent. There is the interesting example of the Dieri, with two moieties only but with an eight-class organisation. Howitt's genealogical table of the Dieri(2) will be found to follow the pattern of the Aranda table if the a1, A1 terms be transposed.

With regard to the form of the four-class table, the following more simple linkage would appear to give a satisfactory picture of the marriage and descent relationships:—

a	A	b	B	a	A
	B	b	A	a	B
	A	b	B	a	A

But it will be noticed that the only marriages provided for in this arrangement are those of a man's marriage with his father's sister's daughter, and a woman's marriage with her mother's brother's son. The converse marriages with mother's brother's daughter and father's sister's son are not represented. To provide for these the long links of the four-class diagram are necessary, and it will be found that this diagram in a new way represents a three dimensional form. Imagine a square vertical column seen from the front of one face, and let each vertical edge represent one of the vertical lines of the diagram. The Banaka BURUNG marriage links will run across the front face, the BANAKA Burung across the back face. The marriage links Palyeri KARIMERA, and PALYERI Karimera, will run from before backwards on the lateral faces of the column. Marriage links of alternate generations are, therefore, diagrammatically on planes at right angles to one another. This can be shown in another way. If each line of the diagram be written as if seen from above, the form of the three rows will be as follows:—

A1	b1	B2	b2	A1	b1
a1	B1	a2	A2	a1	B1
First Row		Second Row		Third Row	

where sides aA, bB represent brother and sister relationship, and sides aB, bA that of husband and wife.

The geometrical form of the eight-class table can now be reviewed and interpreted in the light of the information provided by this simpler table.

The point of view is from above in the following representation of the successive rows (generations) of the more complex table.

A1′	b1′	A1″	b1″	B2′	b2′	B2″	b2″
a1′	B1′	a1″	B1″	a2′	A2′	a2″	A2″
First Row				Second Row			
A1″	b1′	A1′	b1″	B2″	b2′	B2′	b2″
a1′	B1″	a1″	B1′	a2′	A2″	a2″	A2′
Third Row				Fourth Row			

If these diagrams are compared with the four class, it will be found that exactly the same process is taking place, only the marriage links of the second and third rows join corresponding units of two squares. In the first row marriage lines connect units of front and back rows of individual squares. In the second row the lines, instead of running back along the sides of individual squares, join the "opposite number" of the other square, a2′ links with B2″ instead of B2′, b2′ with A2″ instead of A2′, and so on. In the third row the transverse connections run between squares round the ring of the diagram, and in the fourth row the linkage is front to back in individual squares, as in the second figure of the four-class diagram.

The ring structure of the diagram is readily reconstructed for the four-class table; for the Aranda table a form comprising the outer and inner surfaces of a hollow ring would appear to be necessary.

Turning now to the practical value of the table. Firstly, there are two interesting features in regard to nomenclature. In tribes with an eight-class organisation and a four-class nomenclature, the named classes are almost invariably those represented by the a1′, b1′, a2′, b2′ positions in the table. The Mara[3] and Anula tribes are exceptions. Here the four named classes, when charted, occupy the top line of the diagram in the positions a1′, b1′, a1″, b1″. Otherwise the tabulation works out quite normally. Spencer states that the Mara represent an instance of direct as opposed to an ordinary indirect paternal form of descent. If I read the table rightly, the Mara represent an unusual form of nomenclature not of descent.†

Some eight-class tribes, such as the Warramunga[4] (male descent) state that their classes are grouped in pairs, and the paired classes bear a mutual relation of mother's mother to one another. If the class names are tabulated according to the Aranda diagram, it will be found that these paired names fall into relative positions, such as that of PURULA and NGALA.

A most important service is rendered by the table in the study of relationships.

The vertical lines of direct male and female ascent have been mentioned before, the male showing four groups of subclasses of constant moiety and two-generation cycle, the female two groups of alternating moiety in a four-generation cycle.

For diagonal lines of symmetry the ring nature of the diagram demands a repetition of the plane table in all directions.

Firstly, take any female name of "A" moiety. One generation below and one female place to the right will be found brother's daughter. Lay a ruler on the diagonal line set by these two names, and the diagonal will be found to traverse a series of female names representing the relationships: father's father's sister, father's sister, self, brother's daughter, brother's son's daughter. This series represents a complete circuit of the ring, and therefore is capable of extension *ad infinitum*.

From the woman's brother's point of view the same series of relations is expressed by the same line, except that the names are altered to father's father's sister, father's sister, sister, daughter, and son's daughter. The relationship of wife is one generation directly above that of daughter, and one female place right of sister in the same generation.

An exactly similar series will be found for "B" moiety males and females, only in this case the diagonal extends from above downwards to the left.

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†Since this paper was written, I find that Brown has made this same deduction, "Oceania," vol. i., 1930, p. 40.

Table Showing the Class Relations of the Aranda.

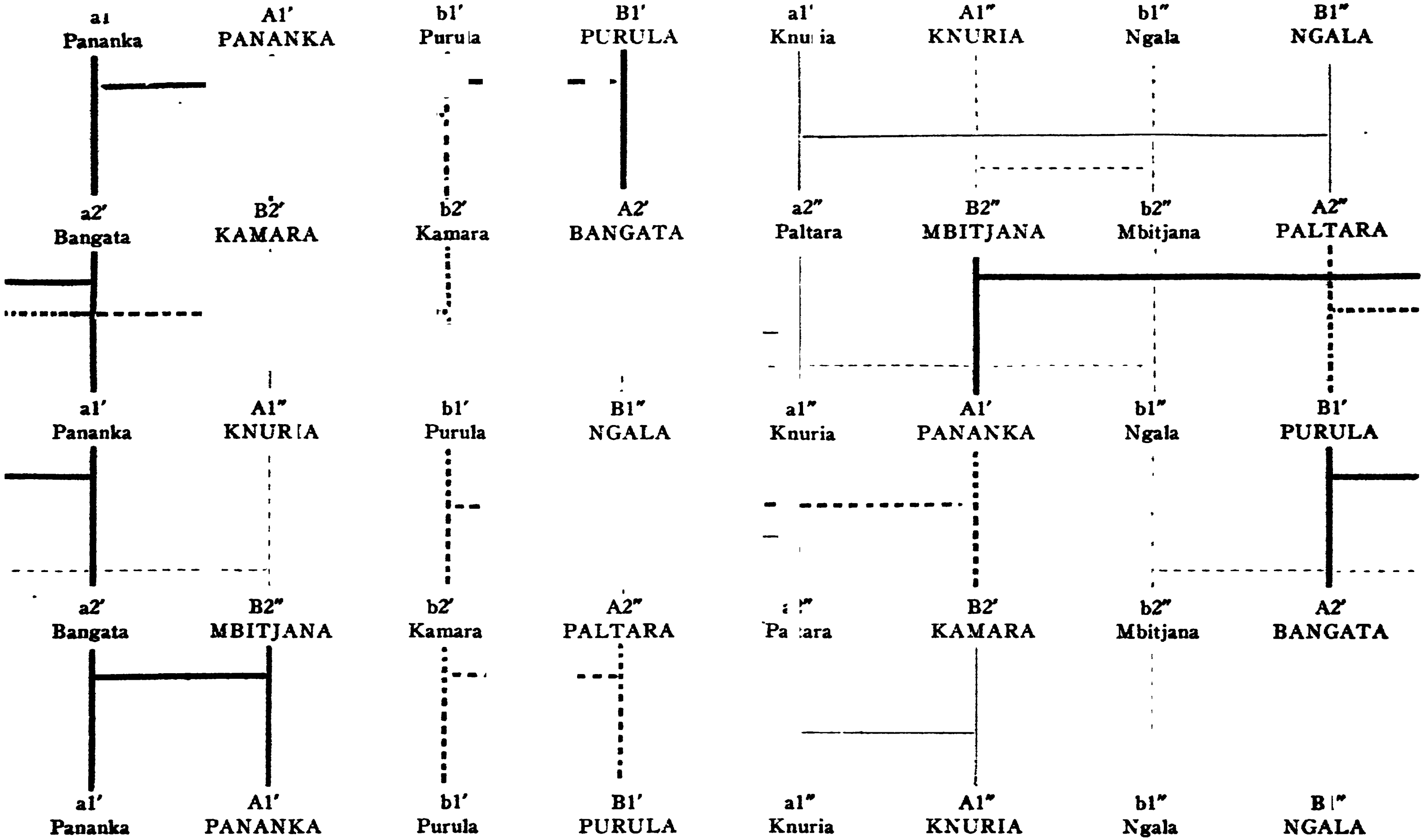


TABLE II.—SHOWING FOUR CLASS RELATIONSHIPS.

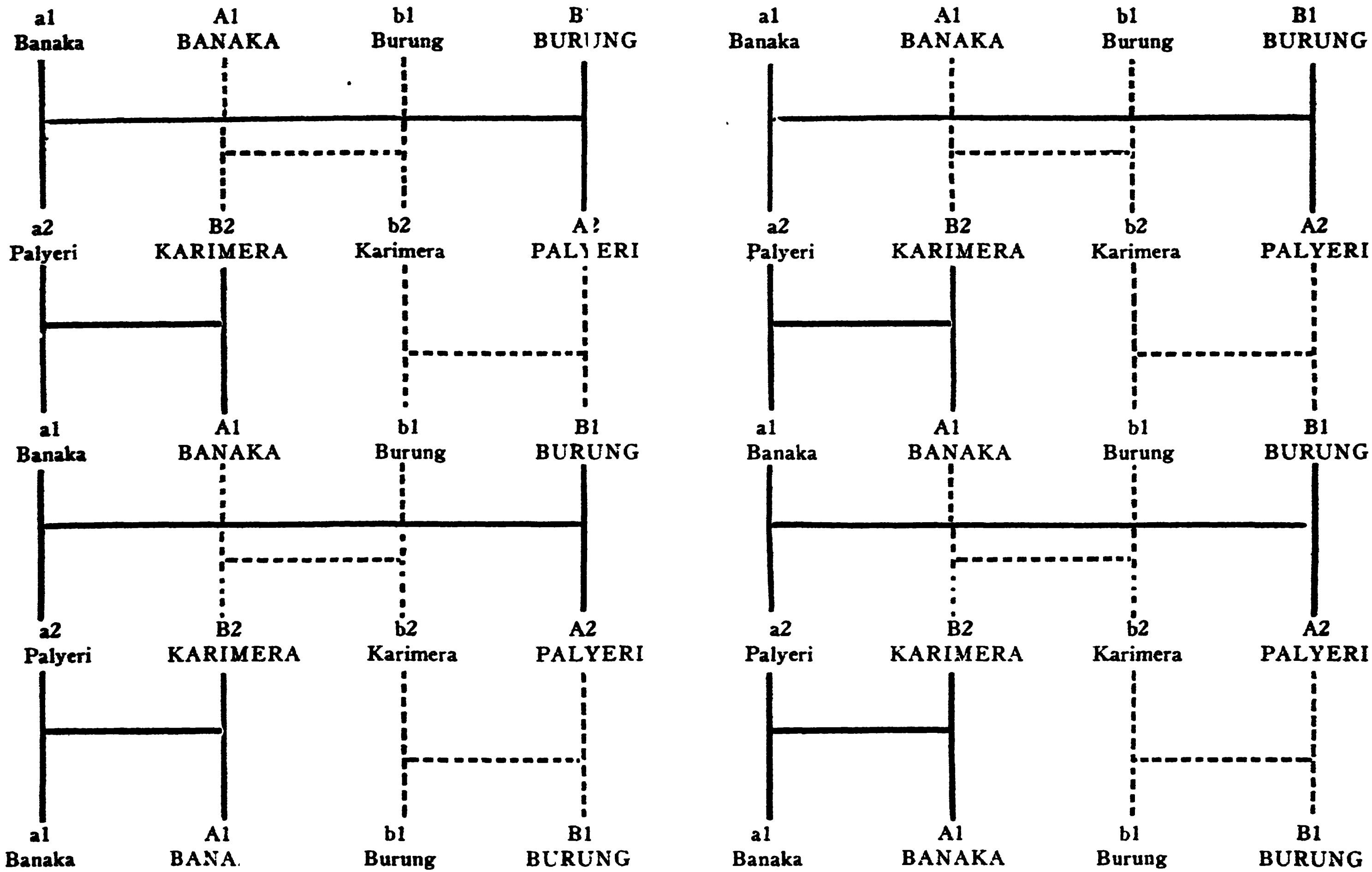
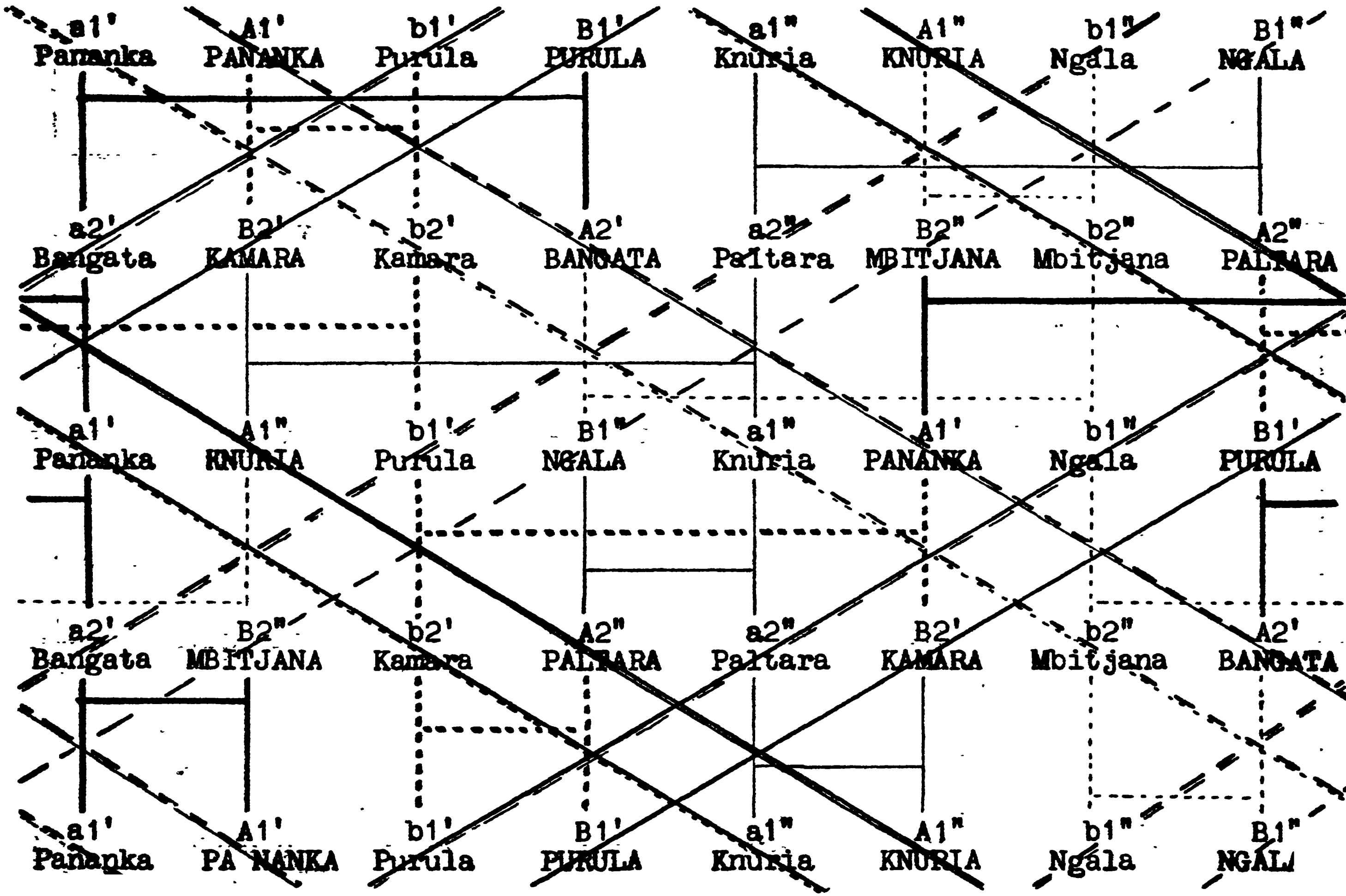


TABLE III.



a1' Pananka
A1' PANANKA
b1' Purula
B1' PURULA
a1" Knuria
A1" KNURIA
b1" Ngala
B1" NGALA
a2' Bangata
B2' KAMARA
b2' Kamara
A2' BANGATA
a2" Paltara
B2" MBITJANA
b2" Mbitjana
A2" PALTARA
a1' Pananka
A1" KNURIA
b1' Purula
B1" NGALA
a1" Knuria
A1' PANANKA
b1" Ngala
B1' PURULA
a2' Bangata
B2" MBITJANA
b2' Kamara
A2" PALTARA
a2" Paltara
B2' KAMARA
b2" Mbitjana
A2' BANGATA
a1' Pananka
A1' PA NANKA
b1' Purula
B1' PURULA
a1" Knuria
A1" KNURIA
b1" Ngala
B1" NGALA

The relationship series mother's mother's brother, mother's brother, brother, son, and daughter's son, from a female standpoint, will be found to lie on a diagonal swinging down and right for subclasses A1′, A1″, B2′ B2″, down and left for subclasses A2′, A2″, B1′, B1″. Husband relationship keeps step one generation above that of son, and one male place right or left of brother. This line indicates the series mother's mother's brother, mother's brother, self, sister's son, sister's daughter's son, from the male point of view.

On these diagonal lines of relationship, it will be found that the female names recur in pairs of constant moiety, the males in two groups of alternating moiety. This is the converse of the vertical lines of relationship.

In Table III., where these lines are indicated, it will be seen that there are four lines of male and four of female connections, the same number as are represented as vertical lines in Table I. If any female oblique line series is compared with any male oblique line series, it will be found that the class names of the respective male and female of the same generation bear to one another a relationship of husband and wife, brother and sister, "ipmunna" to husband or wife, "ipmunna" to brother or sister, in a cycle of successive generations. This again is the exact counterpart of the relation of male and female expressed by the vertical lines. In other words, the pattern of the oblique system of lines is that of Table I., charted for maternal instead of paternal descent, which, as we have stated before, involves no change of pattern of the linkage system. Consequently, the table can be looked upon as a lattice system, hinged on class names of one horizontal row. If the lattice is built with the paternal descent pattern in rectangular form, swinging the vertical lines to a diamond pattern will give the maternal descent form in vertical series; conversely, if built for a maternal descent pattern in the rectangular form, swinging it to a diamond lattice will give the paternal descent arrangement in vertical series. The reciprocating nature of the oblique and vertical relationship series of Table I. with the alternation of paternal and maternal descent is clear.

An expert practical craftsman devoid of theoretical knowledge, can adapt his materials to a new use with the correct technique. In the same way the Urabunna, a two-moiety tribe with maternal descent, and the Aranda, a tribe with an eight-class organisation and paternal descent, are able to make satisfactory arrangements for inter-marriages[5]. This is an interesting example of successful practical application without, necessarily, any appreciation of the theoretical principles involved.

The lattice for the four-class system is similar to the eight-class table, except that in the four-class type there are no "ipmunnas," so the relationships of the class names in the same row in both vertical and oblique systems are those of sister and wife alternately, and four vertical and four oblique lines with a two-generation cycle comprise the relationship series.

References.

(1) Spencer and Gillen, "Native Tribes of Central Australia," p. 71.
(2) Spencer and Gillen, "Northern Tribes of Central Australia," p. 118.
Spencer, "Native Tribes of the Northern Territory," p. 60.
(3) Howitt, "Native Tribes of South-East Australia," p. 159.
(4) Spencer and Gillen, "Northern Tribes," p. 104.
(5) Spencer and Gillen, "Native Tribes of Central Australia," p. 69.

ADELAIDE UNIVERSITY FIELD ANTHROPOLOGY, CENTRAL AUSTRALIA.

No. 9.—ON THE CLASS SYSTEM, KINSHIP TERMINOLOGY, AND MARRIAGE REGULATION OF THE AUSTRALIAN NATIVE TRIBES.

By H. K. Fry, B.Sc., M.B.B.S., D.P.H., Dipl.Anth.

[Read July 9, 1931.]

In a recent paper I have described tables of Australian class systems.(1) These were a development from one of several attempts to represent compactly the class organisation of the Aranda. Class names were charted in vertical lines of male and female descent, and horizontal lines were drawn to indicate marriage unions. The class names of a four-class system were arranged, then, on a similar plan, and the implications of the eight-class table began to appear. The class names of a two-division tribe were found next to fall in the same pattern as the four-class table. An attempt to find a more simple pattern for the two-class tribal system gave the clue to the "double cross-cousin marriage" nature of the form of the table which had been found previously. This led to the full interpretation of the form of the eight-class table. Diagonal lines of "wife" relationships were apparent in the Aranda table as soon as it was drawn up. Other lines of relationship series were found by charting simple relationships on the table in the manner of plotting graphs on squared paper. The tables were drawn up, therefore, without any reference whatever to native relationship terminology, but show patterns of relationships.

Radcliffe Brown has made an intensive study of Australian social organisation, especially from the point of view of native kinship terminology. He has drawn up tables of Kariera type and Aranda type kinship terminology.(2) In these, kinship terms are correlated with an arrangement of classes which are represented by a notation which is different to the general notation used in my tables. Brown adopts capital letters for males, small type for females. I happened on the opposite convention. Brown's notation corresponds with mine as follows:— In the Kariera tables, A = a1, B = b1, D = a2, C = b2; in the Aranda tables, A1 = a1′, A2 = a1″, B1 = b1′, B2 = b1″, D2 = a2′, D1 = a2″, C1 = b2′, C2 = b2″.

The similarities between the two sets of tables are interesting. The Kariera tables are very much alike. In the Aranda tables the same males appear in the vertical lines, which are in different order. If the order of the lines in the kinship table is altered from P R S Q to P R Q S, so making the left half of the table symmetrical with the right half, it will be found that the correspondence of the males in the two Aranda tables is as close as that shown in the two Kariera tables. The four vertical series of "wives" in the kinship table are represented in four diagonal lines in the class table, and conversely the four vertical lines of direct female descent in the class table appear in four diagonal lines in the kinship table, in the P R Q S rearrangement.

The relationships are expressed in the kinship table as translations of the actual native terms, which Brown supplies elsewhere.(3) (4) Several alternative translations are possible for many of the native terms, as will be seen by tracing

out the linkages of either the kinship or the class table. Either table is equally effective.

This demonstration is of importance because it shows that virtually identical results can be obtained by working out the implications of either native kinship terminology or class division.

Brown has taught[5] that the regulation of native social life in general, and of marriage in particular, is the result of native kinship terminology alone. These views have been widely accepted. But this acceptance has been more passive than active, owing to the extreme difficulty of comprehending the complexity of the terms, involving multiple variants, with which the theory in question has been supported. With the aid of the class tables it is possible to visualise the significance of involved relationship terms.

A close study of the data, which have been used to support the theory that social organisation and marriage are dependent only upon the laws of relationship terminology, will show that an explanation is provided equally well by the use of class considerations alone.

The same will be found to be true in regard to the "characteristic features" of Type I. and Type II. marriage law. Further, the marriage permitted by the Variety (a) of Type II. marriage law will be found to be, not a variety of, but a direct contradiction of, the marriage law Type II.

In typical Australian tribes, all the tribal members are representatives of some one class, and are all relatives.

Class tables are genealogical tables of male and female representatives of all the tribal classes, and show relationships genealogically.

The virtual identity, with these, of the tables of kinship terminology is due simply to the fact that the tribal representatives in the latter are arranged in accordance with the *genealogical interpretation* of their respective relationship terms, and are built up in this way into a genealogical table.

It will be seen, therefore, that Radcliffe Brown in his tables, and in his writings generally on Australian social organisation, is dealing, not with mere native kinship terminology, but with the genealogical significance of native kinship terminology, which is identical with the genealogical significance of the native class system.

The theory that Australian native social organisation and marriage are determined by kinship terminology, and not by class system, therefore depends upon a subtle distinction which is actually non-existent.

The question as to what has been the determining factor underlying the development of the more complex class systems is a matter for speculation. There is the explanation from the premises of kinship terminology that an antipathy to marriages of near consanguinity has demanded marriages between individuals of local groups representing comparatively distant degrees of consanguinity, and that a systematisation of such arrangements has resulted in a dichotomy of class nomenclature This can not be disproved in the absence of historical evidence. On the other hand, with the key of the existing class systems, it is a simple matter to draw up organisations for sixteen and thirty two-class systems, the latter with two main alternatives and several minor alternatives. It would be a very difficult matter to work out such arrangements from the basis of relationship terminology. An argument based on class arrangements could explain the more complex organisations by dichotomy or agglutination of pre-existing units. Whether class considerations of themselves have been a primary factor in such development or not is again only speculation, but they have the virtue of enabling things as they are to be expressed graphically and simply.

Similarly the conditions of native marriage may be summarised simply as follows:—

1. The tribal class system determines that a man may marry any woman of his own generation and of a certain class or subclass, named or unnamed, and each such woman is called "wife."
2. "Local rules" in different tribes may:
   (i.) Prohibit marriage with certain "wives."
   (ii.) Permit marriage with women of the same class as "wives" but belonging to a second ascending or descending generation.
   (iii.) Permit "prohibited" marriages with women of a different class to that of "wives" under exceptional circumstances.

The attempt to formulate these conditions into "fundamental laws of relationship terminology" has resulted in an increased complexity of reasoning, and fallacy in deduction. There is also a constant tendency for arguments based on native kinship terminology to drift into arguments involving relationships of consanguinity only.

The class nomenclature system provides relatively simple and safe lines of argument in the investigation of the Australian social organisation, and a useful check on deductions drawn from the more complex terms of kinship.

Addendum.

An illustration of the above is provided by Brown's description of the Yaralde kinship and marriage system, in "Oceania," vol. i. part iv., 1931, p. 452, in terms which imply a latent organisation into at least thirty-two subclasses in a tribe without any class nomenclature. This, of course, is not impossible, but certainly raises the question whether an error has not crept in somewhere.

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(1) H. K, Fry, Trans. Roy. Soc. S. Austr., vol. lv., 1931, p. 12.

(2) A. R. Brown, *Oceania,* vol. i., 1930, pp. 49 and 50.

(3) *Ibid,* p. 323.

(4) A. R. Brown, Journ. of the Royal Anth. Inst. of G. B. and I., vol. xliii., 1913, pp. 153 and 154.

(5) *Ibid,* p. 190, *et seq.*

THE ANATOMY OF AN AUSTRALIAN LEECH, HELOBDELLA BANCROFTI.

By EFFIE W. BEST (née DELAND), M.Sc.

[Read May 14, 1931.]

The material studied consisted of three specimens collected by Dr. T. L. Bancroft, and presented to Professor T. Harvey Johnston, by whose kindness, I was enabled to examine it. Two individuals were in the form of whole mounts, and the third has been prepared as a series of transverse sections. The leeches were obtained from a turtle, *Emydura krefftii*, in the Burnett River, Queensland, but no information is available as to their colour and markings in life. The crops of all three specimens were distended with blood.

This species of *Helobdella* is small, measuring only 6·8 mm. in length and 2·6 mm. in greatest width, and is greatly flattened dorso-ventrally. The leaf-like general form is shown in fig. 1. The mouth is sub-terminal, lying on the second annulus, and the anterior sucker is inconspicuous. The posterior sucker is circular, with a diameter of 1 mm. and is distinctly marked off from the body. The anus opens in the centre of its disc. A pair of eyes is conspicuous at the anterior end of the body, but no segmental sense organs could be recognised. The genital apertures are situated immediately in advance of ganglion 12, and are separated by a single annulus.

Annulation was not obvious in the preparations as mounted, so that internal structures are referred for their position to the nerve ganglion rather than to the superficial marks of segmentation unless the contrary is definitely stated.

The general form of the body wall shows a certain amount of variation in different regions. This is due to the variable proportions of muscular, glandular, and other elements present, rather than to any alteration in the structures composing it. A typical section is shown in fig. 7. The cells of the epidermis are very irregular in shape, approaching a columnar form only at the extremities of the body and in the neighbourhood of the genital apertures. A very large number of epidermal cells are highly granular and modified as unicellular glands. Some of these may be sunk two or three times the depth of the epidermis below the surface, in which case their secretion is poured out through a narrow duct-like prolongation. The epidermis rests on a layer of fibrous connective tissue, the cells of which have particularly deeply-staining, compact, spindle-shaped nuclei. There is no sign of the definite arrangement of longitudinal, circular, and dorso-ventral muscle layers which characterises the more highly organised leeches. Most of the muscle fibres, except those which run in the incomplete septa dividing the somites, are longitudinal. They form irregular masses beneath the epidermis and are almost lacking at the margins of the body (fig. 5). Lying amongst the muscle fibres and scattered in the connective tissue are a number of very irregular, large, pigment cells containing a highly refractive, granular substance. Minute capillary vessels of the coelomic system form an intricate network among the superficial layers of the body wall, and the larger collecting sinuses with which these ultimately communicate, lie in the deeper layers.

The main coelomic spaces are four in number, dorsal, ventral, and lateral. The largest is the ventral sinus (fig. 4, 5, 8), in which lie the nerve cord, ventral blood vessel, and the various ducts of the reproductive systems, as well as portions of the alimentary canal, and into which the ciliate funnels of the nephridia open. For the greater part of the body length this space assumes almost the dimensions

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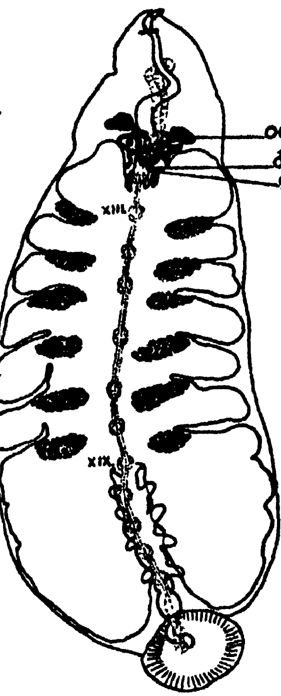
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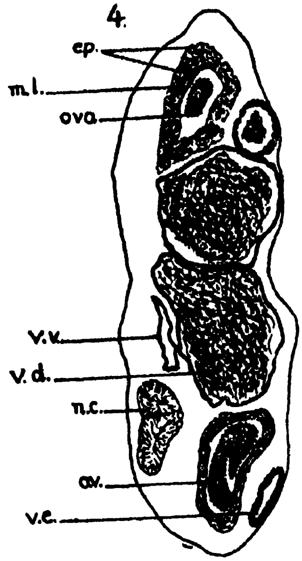
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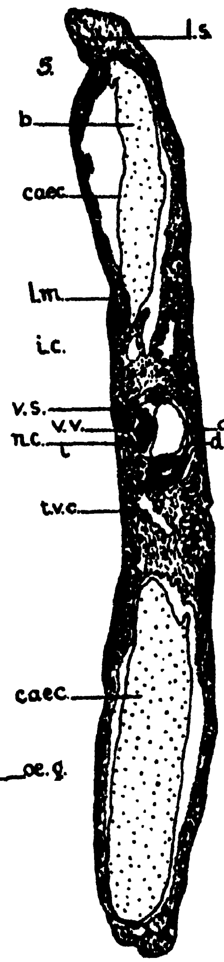
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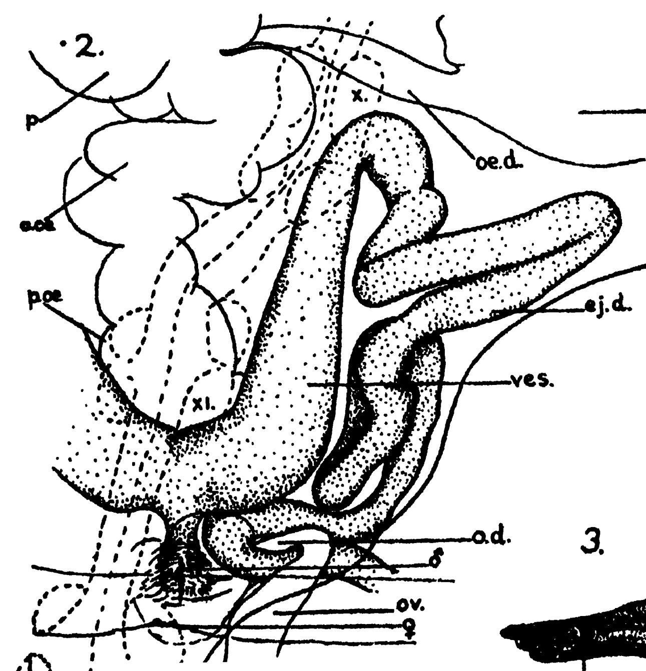
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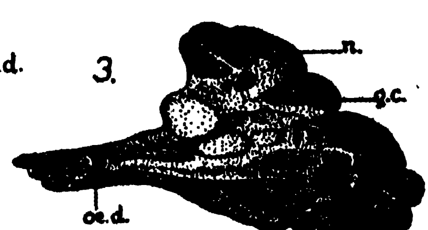
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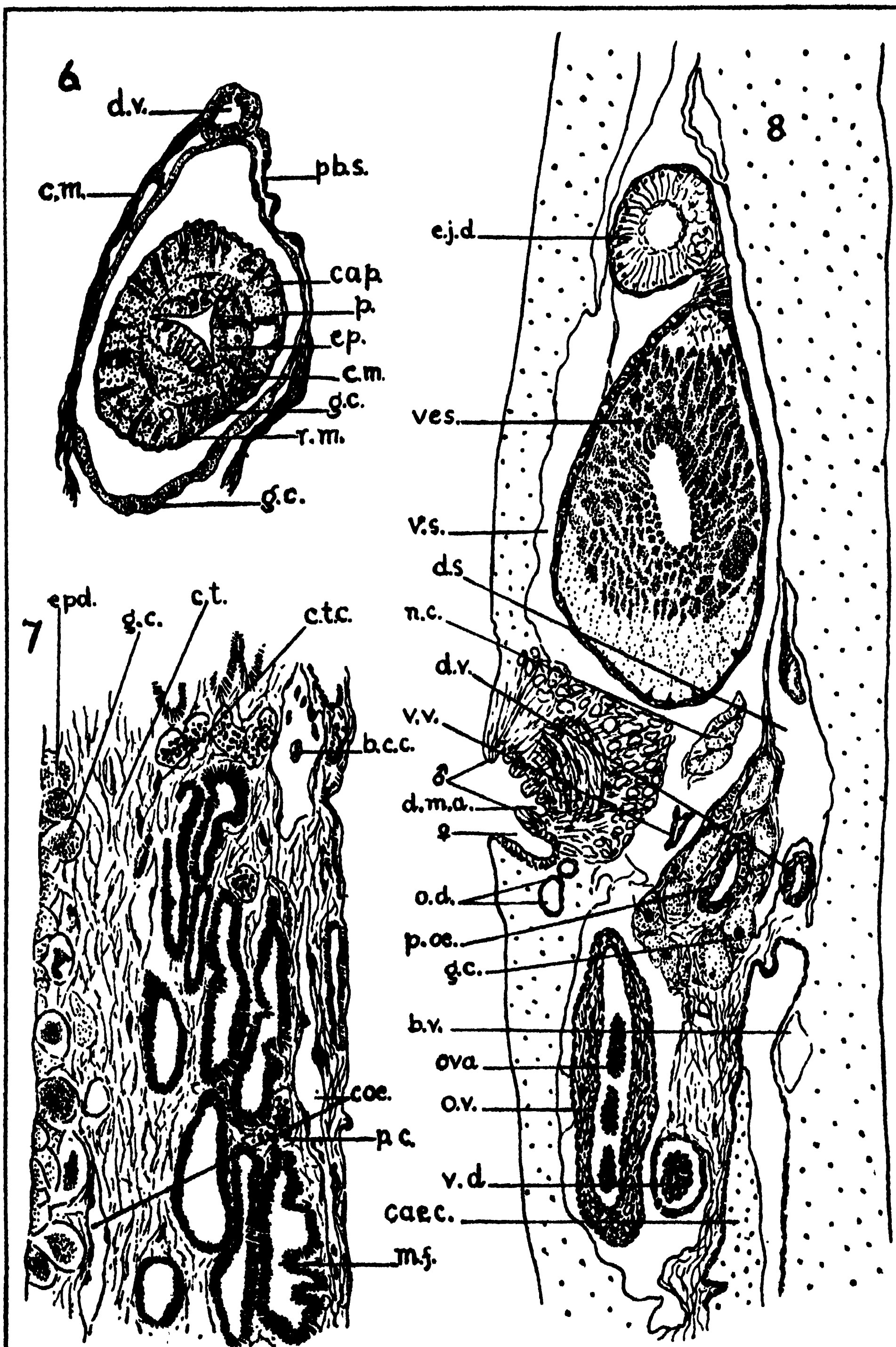
and relationships of an ordinary coelomic cavity. At both extremities of the body the ventral sinus narrows considerably and is lost among the network of fine cavities connecting it with the dorsal and lateral sinuses. The dorsal sinus is much smaller and would be indistinguishable from the larger of the subcutaneous sinuses if it were not for the presence of the thick-walled dorsal vessel within it. It is connected at both ends with the ventral and lateral sinuses by the network of capillaries already mentioned. The lateral sinuses run very close to the margin of the worm, and the body wall above them is composed of the epidermis and a loose parenchyma, but no muscle fibres. These sinuses are dilated somewhat in each segment and give off metamerically-arranged branches (the transverse coelomic spaces) to the ventral sinus. They also receive numerous branches from the subcutaneous system of spaces whose arrangement has already been described in the account of the body wall. Except in the large size of the ventral sinus this arrangement of sinuses closely follows that described by Bourne in *Glossiphonia (ulepsine)*. All these coelomic spaces are lined by an epithelium of large, squamous cells whose nuclei project into the lumen of the sinus. The coelomic corpuscles are small, usually rounded and often binucleate (fig. 7).

Closely connected with the sinus system are the so-called blood vessels. There are two main trunks, dorsal and ventral, lying in the corresponding sinuses and connected at both ends by a series of capillaries indistinguishable from those of the sinus system. The dorsal vessel is strongly muscular and lies immediately above the alimentary canal (fig. 5, 6, 8). The ventral vessel is larger, thin-walled, and lies just above, and usually close to, the nerve cord.

The alimentary canal has the same general arrangement as is present in other members of the genus. There are a retractile proboscis, an oesophagus, a crop with seven pairs of diverticula, and an intestine. The proboscis sheath is lined by a layer of squamous cells continuous with those of the epidermis and, like them, often granular, showing their glandular function (fig. 6). Outside this is a layer of loose muscular tissue whose fibres are more or less circular, and in which the thick-walled dorsal blood vessel is present. This, in turn, is surrounded by the ventral coelomic sinus. The lumen of the proboscis is trifid in transverse section, and is lined by an irregular columnar epithelium. The muscles of the proboscis consist of a very thin sheet of circular fibres and a number of radial fibres with which are interspersed groups of granular secreting cells. In a whole preparation these radial fibres and the gland cells are seen to be quite regularly arranged, giving the peculiar appearance shown in fig. 15. The epithelium surrounding these structures is squamous, like that of the sheath. A very fine cuticle was observed in places, lining the lumen of the proboscis and of the sheath, and covering the former. Towards the base of the organ the structure of its wall becomes rather looser, and the gland cells stain more deeply with eosin. At the base of the proboscis a thin-walled portion of the alimentary canal receives the ducts of the oesophageal glands, and may be termed the anterior region of the oesophagus. This forms loose coils when the proboscis is retracted, but is probably drawn taut by its extension. The posterior region of the oesophagus is lined by a columnar epithelium, similar to that of the anterior part and surrounded by large glandular cells with peculiar and very obvious nuclei (fig. 8). The stomach or crop follows upon the oesophagus in somite 12 and with its diverticula occupies the greater part of the body from somite 11 to the base of the posterior sucker. The form of these structures may be seen in fig. 1. The stomach passes into the intestine at somite 19. The latter is lined by a glandular, columnar epithelium and bears four segementally arranged caeca whose epithelium is of a similar type. At somite 24, the intestine opens by a sphincter into the anterior swollen portion of the thin-walled hind gut. The narrow rectum opens by the anus in the centre of the posterior sucker.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The oesophageal glands are a pair of conspicuous, compact, triangular organs lying in somites 8 and 9. The cells composing them are large, with densely granular protoplasm which stains deeply with eosin. The nuclei are rather small and are situated against the outer boundary of the organ. The cells are pyriform and their tapered ends unite to form the duct of the gland, so that the constituent cells retain their individual connection with the oesophagus in spite of the compact nature of the gland.

There are six pairs of testes, situated between the crop diverticula in somites 13/14 to 18/19. From each testis a thin-walled vas efferens unites with the vas deferens of its own side. This duct passes forward within the ventral sinus and median to the ovary where this is present. Each vas efferens runs side by side with the vas deferens for some distance, eventually joining it at about the level of the preceding testis. In somites 10 and 11, the vas deferens of each side is thrown into coils within the space median to the anterior caeca of the stomach. This coiled ejaculatory duct passes anteriorly into a large club-shaped vesicula seminalis on each side of somite 10. These organs extend posteriorly to the boundary of the annulus containing the male aperture, and are 1 mm. in length and ·04 mm. in their greatest diameter. The wall of the vesicula is composed of an outer layer of circular muscle continuous with that of the ejaculatory duct and an inner zone of very large cells, clear towards their outer extremities and very granular towards the lumen of the organ. At the narrow anterior end these cells merge into the clear, tall columnar epithelium of the ejaculatory region of the vas. The nuclei of the secreting cells are small and close to the muscular coat. The lumen of the vesicula is irregular, the tapered distal portion of each secreting cell projecting into it in the form of a minute papilla (fig. 8). This arrangement is doubtless connected with the formation of spermatophores within the organ. The two vesiculae seminales unite near the midline, below the ventral nerve cord, to form a short muscular common duct opening at the male aperture. Below this duct is a small blindly-ending depression lined with columnar epidermal cells similar to those covering the immediate neighbourhood of the genital apertures, and opening at the male pore. In the sectioned specimen male activity was apparently nearly past. The testicular sacs contained only a few scattered sperm morulae and a number of large cells with a reticular or highly vacuolate protoplasm. On the other hand, the portions of the male ducts contained within the ventral sinus, both vas deferens and vasa efferentia, were swollen with masses of sperms embedded in some sort of prostate secretion. The histological form of these various cells is shown in fig. 9a, b, c.

The ovisacs apparently vary considerably in size according to the sexual condition of the individual. In one specimen examined as a whole mount they extended very little behind the ganglion of somite 12, whereas in the material sectioned they reached somite 16 posteriorly and showed, in addition, an anterior caecum which extended into somite 10. The structure of the wall of the ovisac varies little in its entire length. Both within and without there is a squamous epithelium which may be thrown into small folds. The main thickness of the tube consists of a layer of very small muscle fibres in a connective tissue matrix. In the neighbourhood of the genital pores these and the fibres of the common male duct approach those of the body wall in size and become indistinguishable from them.

Nephridia are absent from the part of the body anterior to the genital apertures and from the posterior sucker. The nephridial funnel is connected with the ventral sinus and the nephridiopores open ventrally in the median third of the body. The coils of the nephridia extend to the margin of the body just inwardly from the lateral sinus. The ciliate funnel (fig. 10) is long and narrow and lined with very long cilia. Its extremity is bifid, each lobe being further partly sub-

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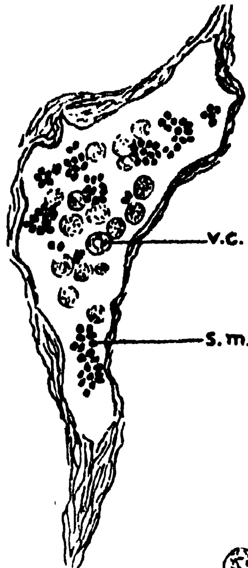

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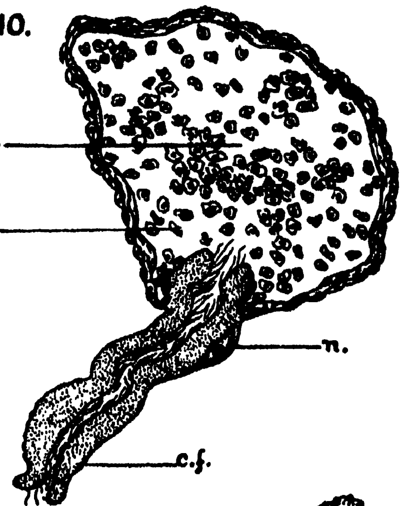

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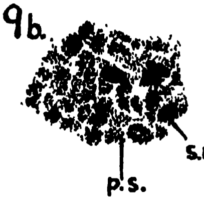

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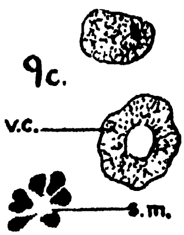

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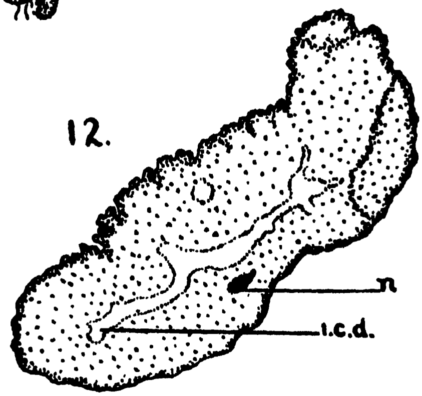

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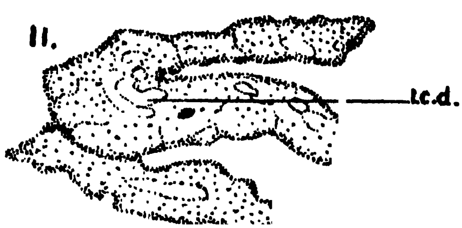

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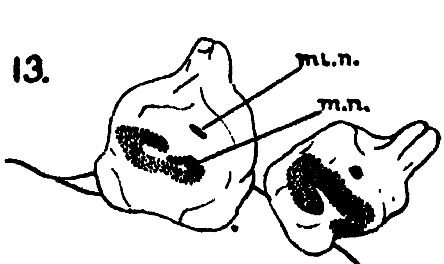

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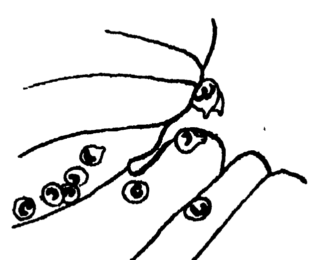


divided into two, and each of these four divisions bears a nucleus. Another nucleus is present at the base of the structure. The funnel projects a little into the dilatation following upon it, and here two smaller nuclei are present. This dilatation takes the form of a large sac whose walls are formed of a single layer of cells surrounding a fibrous capsule. Its lumen is filled with coelomic corpuscles. The tubules of the nephridium extend outward to the margin of the body and then return to open by the nephridiopore just ventral to the ciliate funnel and a little behind it. Typical cells of this nephridial tissue, with their intracellular ducts, are shown in figs. 11, 12. The ciliate funnels lie just in advance of the ganglion in the somite which contains them. In all these respects the nephridia resemble those of other members of the same family fairly closely.

The central nervous system has the general character described in detail by Hemmingway for *Placobdella pediculata*. The highly organised eyes lie well beneath the surface on the third annulus. Each consists of a cup-shaped mass of pigment of the same type as that contained in the ordinary pigment cells of the body wall, which are in this region very numerous (figs. 17, 18). The cup is filled with clear cells of the usual type, but no axial fibres were observed. The front of the cup is filled by a mass of cells reaching the surface of the body at one point and extending slightly beyond the limits of the pigment layer. The nuclei of these cells are seen in section to be situated round the periphery of the mass which is enclosed in a distinct capsule. The protoplasm of these rod-like cells is finely granular. They are homologous with the "tactile cells" described by Whitman, but appear to be more specialised as an optical medium than any studied by him, judging from Miss Merrill's summary of his work. In the present species these cells form a distinct, clear cornea-like structure, filling the space between the cells of the optic cup and the surface. The nuclei of these "tactile cells" differ from those of similar cells of the marginal sense organs in the more open nature of their chromatin network.

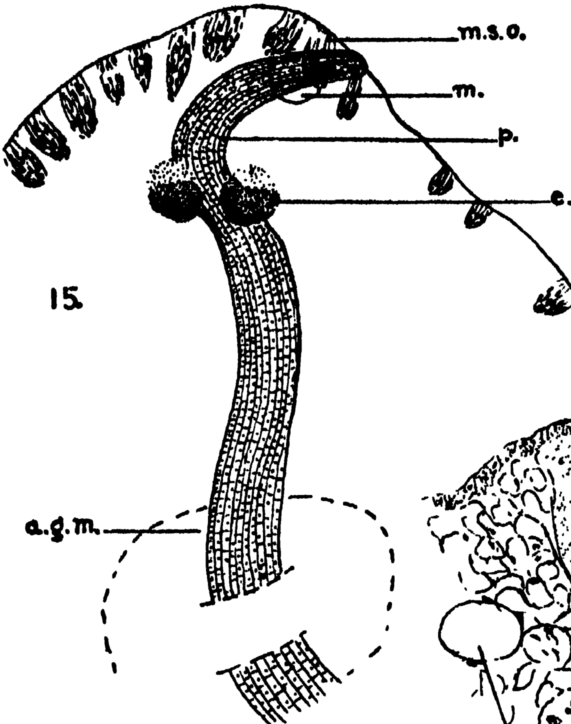
Segmental sense organs or sensillae of the usual type were not observed, but the anterior margin of the body is bordered by marginal sense organs. These take the form of groups of rod-like sensory or tactile cells whose protoplasm is densely packed with fine granules and whose nuclei are spindle-shaped. Capillary vessels occur among the sensory cells.

Attached to one of the specimens were many solitary, peritrichous ciliates, collected along the edges of any depression on the surface. Their form is shown in figs. 13, 14.

The new species of leech has all the characters of the genus *Helobdella* R. Blanchard, 1896 (Glossiphoniidae), and the name *H. bancrofti* is proposed for it in recognition of assistance rendered by Dr. T. L. Bancroft. Its most obvious specific characters are the absence of a dorsal scute, the very compact nature of the oesophageal glands, and the small size of the intestinal caeca.

This appears to be the first record of a member of this genus from Australia, though Goddard (1908-9) described several species of the related genus *Glossiphonia*.

The type slide is being deposited in the South Australian Museum.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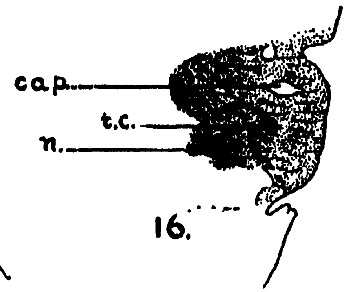
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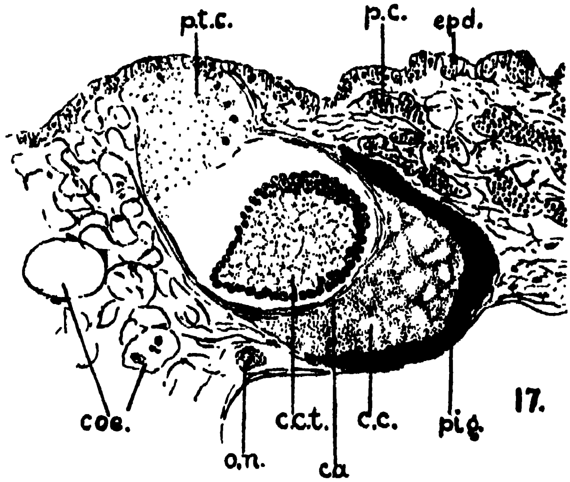
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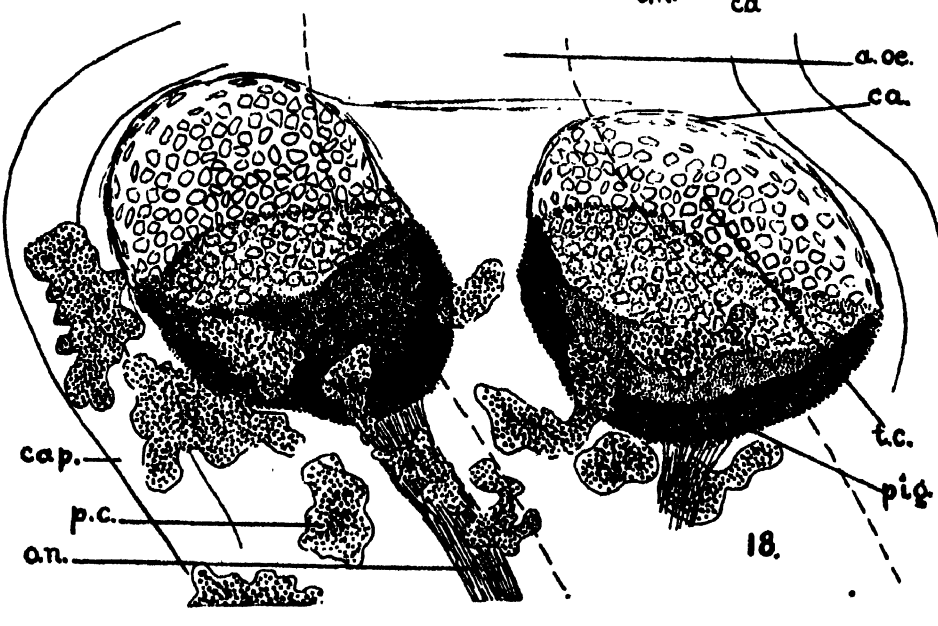
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18.

LIST OF FIGURES.

All the transverse sections are somewhat oblique.

EXPLANATION OF LETTERING.

a.g.m., anterior ganglionic mass; a.oe., anterior region of oesophagus; b., vertebrate blood in crop; b.c.c., binucleate coelomic corpuscle; b.v., blood vessel; ca., capsule surrounding corneal cells; caec., caecum of crop; cap., capillary; c.c., clear cells; c.c.t., corneal cells, "tactile"; c.f., ciliate funnel; c.m., circular muscle; coe., coelomic space; coe.c., coelomic corpuscle; c.t., connective tissue; c.t.c., connective tissue corpuscle; d., duct; d.m.a., depression below male aperture; d.s., dorsal coelomic sinus; d.v., dorsal vessel; e., eye; ej.d., ejaculatory duct; ep., epithelium; epd., epidermis; g c., gland cell; i., intestine; i.c., intestinal caecum; i.c.d., intra-cellular duct; l.m., longitudinal muscle; l.s., lateral coelomic sinus; m., mouth; m.f., muscle fibre; mi.n., micronucleus; m.l., muscular layer; m.n., meganucleus; m.s.o., marginal sense organ; n., nucleus; n.c., nerve cord; n.d., nephridial dilatation; o.d., oviduct; oe.d., duct of oesophageal gland; oe.g., oesophageal gland; o.n., optic nerve; ov., ovisac; ova., mass of developing ova in ovisac; p., proboscis; pb.s., proboscis sheath; p.c., pigment cell; pig., pigment cup; p.oe., posterior region of oesophagus; p.s., prostate secretion; p.t.c., prolongation of corneal cells ("tactile") towards surface (cut obliquely); r.m., radial muscle; s.m., sperm morula; s.n., sperm nucleus; t.c., tactile cell; t.v c., transverse coelomic space; v.c., vacuolate cell; v.d., vas deferens; v.e., vas efferens; ves., vesicula seminalis; v.s, ventral coelomic sinus; v.v., ventral vessel

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GEOLOGICAL NOTES ON THE ILIAURA COUNTRY NORTH-EAST OF THE MACDONNELL RANGE, CENTRAL AUSTRALIA.

By NORMAN B. TINDALE, South Australian Museum.

[Read June 11, 1931.]

During the combined Adelaide University and Museum Anthropological Expedition to MacDonald Downs, August-September, 1930, some notes were made on the geology of the country forming the headwaters of the Mubunji (Bundey) Creek and its tributaries, the Abmoara (Fraser), Alpara, and Irukaru Creeks.

The outward journey from Alice Springs was made by means of motor trucks, and followed a new track on the northern side of the MacDonnell Range, *via* Bird and Turner Wells, South Point, Ilarndanga (Kerr's Station), Tjeruka (Peaked Hill), and down the Abmoara Creek to Lilatara (135° 9′ east long. x 22° 25′ south lat.), at the junction of Abmoara and Alpara Creeks, where the head station of MacDonald Downs (owned by Mr. C. O. Chalmers) is situated. The outward journey did not afford many opportunities for detailed observations, but on the return trip, which was made by a different route *via* Ilarndanga, the Upper Mubunji, Table Hill, Hart's Range, Arltunga, and thence by the main track through Undoolya to the Alice, several short detours were made to points of interest in the area herein discussed.

During our three weeks' sojourn, the localities examined included the vicinity of Lilatara; Undala or Bundey Gap, six miles north; Arapia, eight miles north; India Range, three miles south; Ataparapara (Mount Ultim), twelve miles east by south; Mopunja Range, eight miles south-west of Mount Ultim; also Table Hill and its vicinity.

The Alpara Creek rises near Mount Swan and follows first a north-easterly and then a northern course to Lilatara (*lila*, creek; *tara*, two), where it joins the Abmoara. On the present official maps it is wrongly shown as a tributary of the Apewunga (Plenty) River, which has its source near the Hart Range, and flows eastward and then somewhat more southward past the Jervois Range.

Irukaru Creek has its sources in the gently undulating plateau country south-west of Mount Ultim and, after skirting the western flanks of the latter, enters the Mubunji (Bundey) at Undala.

The Alarinjela (Marshall River) has one of its sources on the southern side of Mount Ultim, and flows south-eastward past Atnoala Springs, to join the Apewunja River. The low plateau between the Alarinjela and Irukaru is, therefore, on the north-south divide of the MacDonnell Range, which has hitherto been placed much too far to the north-west. Mistake Creek rises on the eastern flank of Mount Ultim and flows east, and then north, to the Sandover. Apparently no previous description of the geology of the area has been published. The country further east was examined by Brown (1), who approached it by a southern route *via* Arltunga and the lower reaches of the Plenty River.

The MacDonnell Range Pre-Cambrian complex underlies the area at no great depth. Gneisses, schists, with both acid and basic igneous rocks, are present.

At Mopunja Range (fig. 2) these rocks form an extensive peneplain emerging from a mantle of sediments. At this place three small outcrops of basic igneous rocks have been extensively worked by aborigines for the manufacture of stone axes.

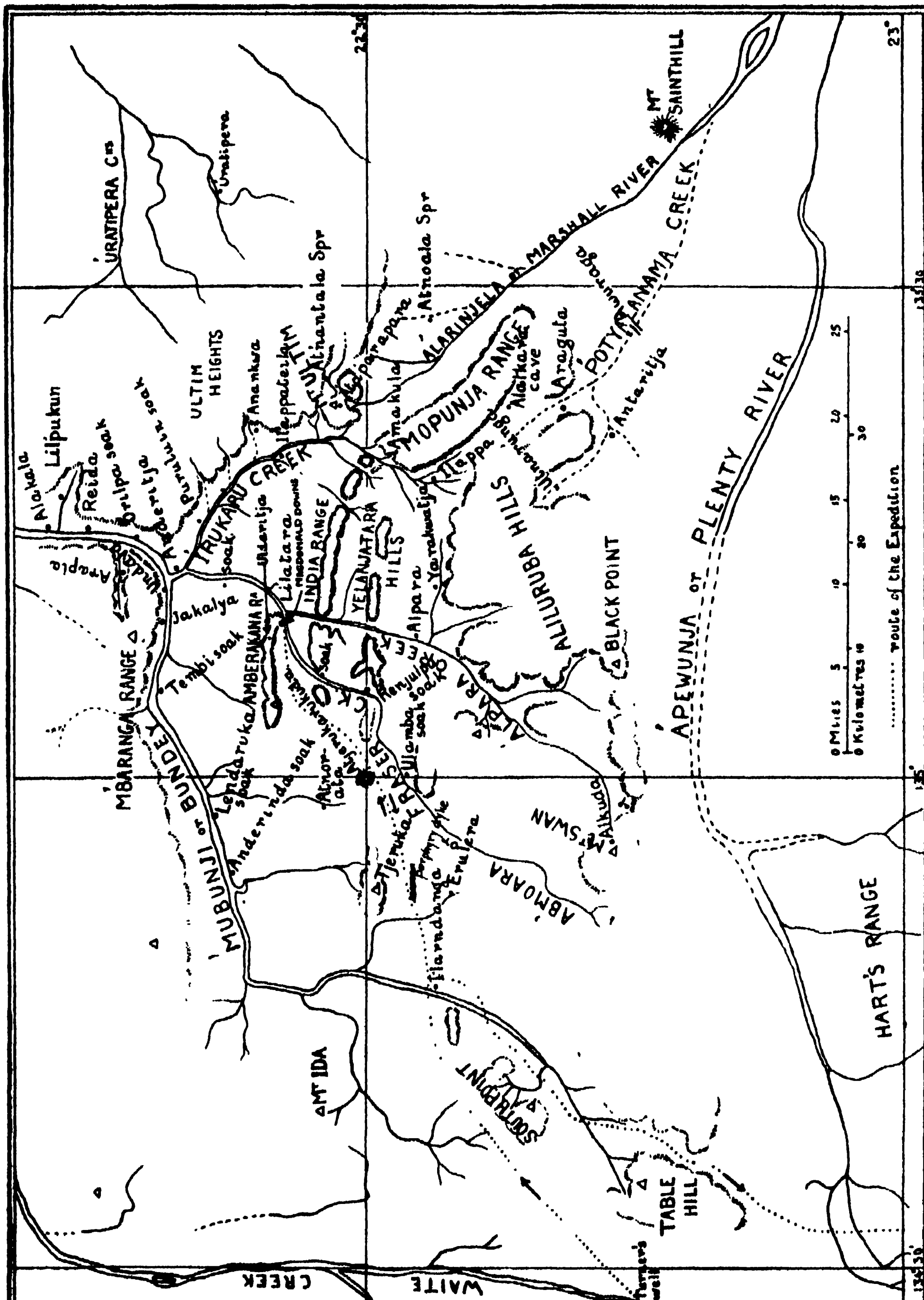


Fig. 1.

Sketch Map of the Iliaura Country, North-east of MacDonnell Range, Central Australia.

Several vertical dykes of coarse granite-porphyry run east and west across the country on the Pre-Cambrian plateau south of Peaked Hill. This plateau extends eastward from Ilarndanga (Kerr's Station), for about twelve miles, to within a mile of Atjerukarukuda Rock, a characteristic outcrop of weathered granite rising a hundred feet from the alluvial plain. Further south the Old

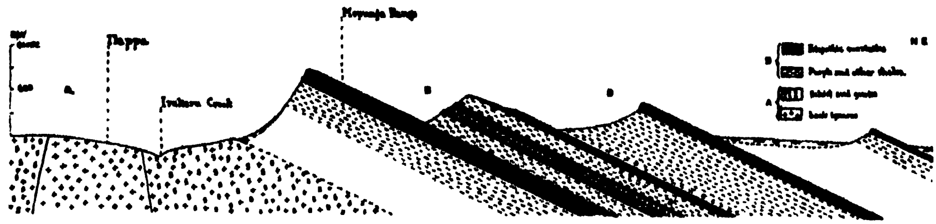


Fig. 2.
Sketch Section at Mopunja Range (c. 2 miles).

Rocks are concealed by limestone and chalcedony beds which form low table-topped hills. Still further south they reappear in the area dissected by the head-waters of the Apewunja River.

Lying directly on the Pre-Cambrian gneisses and schists at Mopunja Range is an extensive sedimentary series, consisting in the main of shales and quartzites (fig. 2). These beds dip at an angle of about 25° to the east-north-east, presenting

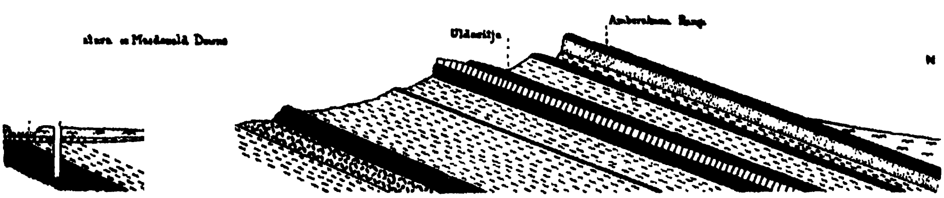


Fig. 3.
Sketch Section, Abmoara Creek to Amberakana Range (¾ mile).

on their western aspect a steep quartzite scarp and a slope estimated to be seven hundred feet in height.

Further to the south the strike of these beds sweeps to the east in an even curve, while to the north-west the strike turns gradually to the west, so that at Lilatara similar beds dip a little east of north.

At India Range, which runs almost due east and west, sections of beds which appear to be somewhat higher up in the Mopunja Range series are met with (fig. 4). The beds dip at about 20° to the north-north-east. They consist of

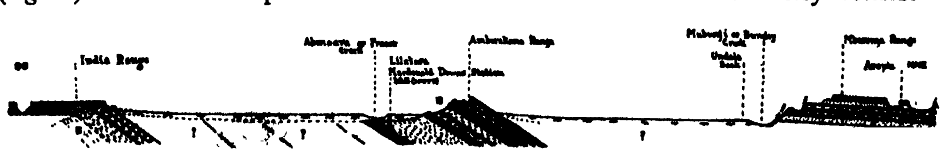


Fig. 4.
Sketch Section, India Range to Bundey Gap (10 miles).

alternating quartzites (sometimes very fine grained, but usually coarse and felspathic) and altered shales containing abundant large flakes of detrital mica. West of the gap (three-quarters of a mile wide) through which the Alpara Creek passes,

the Mopunja Beds are overlain by horizontally-bedded limestones capped with chalcedony. The unconformity is well revealed in a series of small side valleys.

Three miles north of this gap, across an alluvial plain strewn with chalcedony gibbers derived from the breaking down of the limestone plateau, a further section of the Mopunja Beds is revealed at Lilatara (figs. 3, 4). The well on the bank of the Abmoara Creek (in which good water was struck in a coarse felspathic grit at 90 feet) revealed some of the features underlying this plain:—

		Feet.
Horizontal Beds.	Red soil	to 10
	Cemented grit with white chalcedony pebbles..	„ 18
	Limestone	„ 20

		Feet.
Beds Dipping c. 20° to North.	Purple and yellow shales	to 64
	Coarse red siliceous sandstone	„ 77
	Shale	„ 78
	Felspathic grit	„ 90

Purple shales similar to those present in the well outcrop at the base of Uldaritja Hill, several hundred yards to the north-west, and are conformable with alternating thin quartzites and shales, with some fine conglomerates. These beds may be enumerated here, in descending order (with approximate thicknesses), as being typical of the Mopunja series as a whole:—

Coarse felspathic quartzite	10
Coarse quartz grit	15
White shale	10
Coarse felspathic quartzite	5
Purple shales	30
Coarse felspathic quartzite	5
Fine quartzite	10
Coarse felspathic quartzite	15
Shales with a thin quartzite and some argillaceous sandstone ..	90
Coarse felspathic quartzite	20
Coarse iron-stained grit or fine conglomerates with unabraded fragments of crystalline constituents	20
Purple shales	?

The shales everywhere show signs of disturbance, and the felspathic quartzites are permeated by polished slickenslide faces. The aborigines naively account for the latter by saying that some mythical ancestors milled grass seeds upon the rocks.

Looking northward from Mopunja, and from Lilatara, across an alluvial plain about five miles wide, there can be seen a series of almost horizontally-bedded sediments (of different character from those already described) which extend for some twenty miles across the northern horizon. These beds consist of bright red sandstones and fine quartzites, together with a few argillaceous sandstone horizons. They dip at a low angle (about 3-5°) to the north-north-east, and by their character indicate that they are of littoral origin. Current-bedded and ripple-marked sandstones are well developed, together with numerous fossil beds. In character and content they stand in marked contrast to the beds of the Mopunja series, and, therefore, it is suggested that an unconformity may be discovered between them.

Between Undala and Mount Ultim these sandstones form a plateau sloping gently to the north; it stands four to eight hundred feet above the plain. The south-western margin of this plateau forms a steep scarp and slope, only slightly cut into by a series of small valleys at regular intervals along its margin. Upon

the top of the plateau there is a series of smaller flat-topped residuals (culminating in Mount Ultim itself) which have resisted weathering. North of Undala this plateau dips gradually towards the vast Sandover Plain.

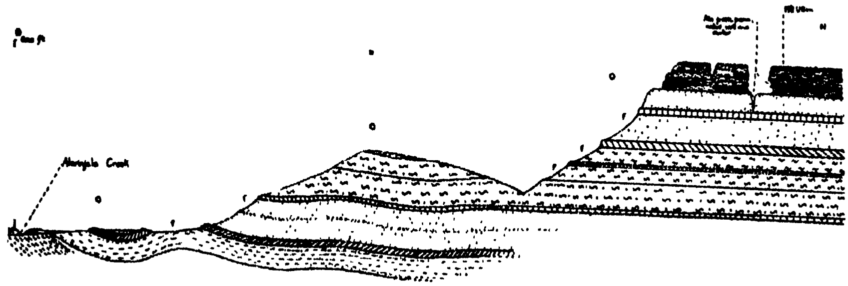


Fig. 5.
Sketch Section, from Alarinjela Creek to Mount Ultim (2 miles).

The first observations on these beds were made at Arapia and at Undala, where fossils, in the form of "worm-tracks" and ? *Orthoceras* casts were discovered, but, as the same horizons were afterwards identified and examined in detail at Mount Ultim, the latter occurrence will be described in preference.

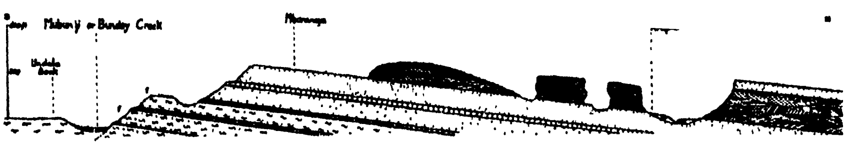


Fig. 6.
Sketch Section, from Undala to Arapia (c. 2 miles).

The Mount Ultim occurrence consists of a thickness of about 800 feet of sediments (fig. 5) which, in descending order, consist of:—

		Feet
Current-bedded Sandstone	approx.	100
Massive red sandstone	,,	80
White quartzite with an *Orthoceras* horizon at its base	,,	20
Red sandstone with *Raphistoma*	,,	100
Current-bedded gritty quartzite	,,	30
Argillaceous sandstone with "worm-tracks" and ripple-marks	,,	50
Fine Quartzite	,,	10
Red sandstone with "worm-tracks" and ripple-marks ..	,,	60
Quartzite	,,	c.5
White argillaceous sandstone with fossils	,,	100
Quartzite	,,	10
Argillaceous sandstone	,,	120
Highly crystalline quartzite	,,	20
Grey argillaceous sandstone with fossils	,,	100
Shale	,,	?

The current-bedded quartzite forming the summit of Mount Ultim is weathered into numerous shallow caverns and leaning rock-shelters, which have been made use of by aborigines. The mode of weathering is so characteristic a

feature of this bed wherever it outcrops that the natives have a rational explanation for the occurrence, which takes the form of a legend explaining how a mythical being commenced shelter-making operations many miles to the west and proceeding south-eastward, excavated shelters in turn at Arapia, Mount Ultim, Mistake Creek, etc.

At Undala (fig. 6) a bed which was identified with "fine quartzite" of the Mount Ultim series forms a smooth flat surface, upon which the natives have cut a few simple figures. Above and below it there are, as at Mount Ultim, red

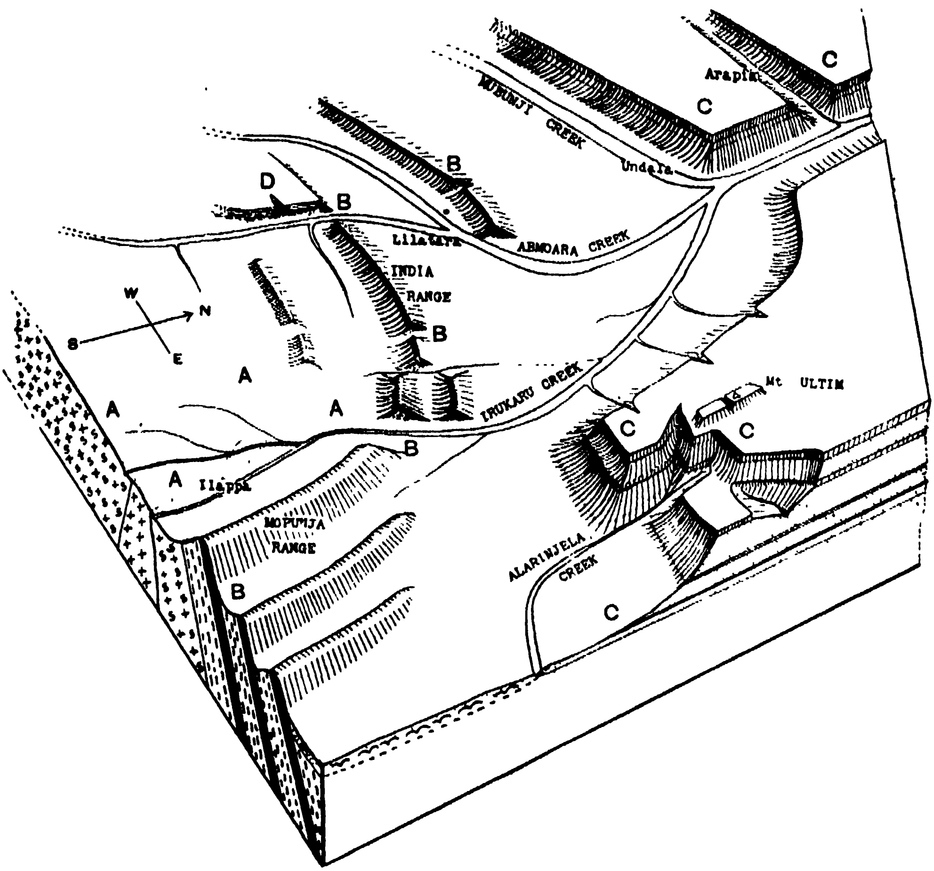


Fig. 7.
Block diagram of the vicinity of Lilatara.

sandstone beds with abundant "worm-tracks." Many of the boulders also show fine ripple marks. Beds lower in the series do not outcrop.

North of Arapia the current-bedded sandstone, corresponding to the beds forming the summit of Mount Ultim, are capped by silicified sandstone. Further to the north the beds appear to dip at a low angle towards the alluvial sediments of the Sandover. Limestone beds, capped by chalcedony, are stated to occur further to the north, but were not examined.

A representative series of fossils from these beds has been lodged in the Palaeontological Collection of the S.A. Museum, and it is hoped that their identification will be soon carried out.

Several references have been made to the occurrences of limestone beds capped by chalcedony. At India Hill they lie unconformably on the Mopunja series (fig. 4), while according to Mr. C. O. Chalmers similar beds to these occur north of Arapia. At the first-named place the beds in descending order were observed to be:—

	Feet
Chalcedony	6
Limestone	6-20
Kaolin	10
Red ferrugineous grit	?

In the whole of the south-eastern part of the area under discussion and around Table Hill and South Point this formation has given rise to a partly dissected plateau, traces of which can be seen in the form of table-topped hills up to one hundred feet in height. The breaking up of this extensive formation has also given rise to the larger or smaller chalcedony gibbers which everywhere strew the alluvial plains and, as coarse grit or gravel, helps to choke the wide sandy beds of the creeks.

Summary.

Representatives of what appear to be three, possibly four, geological series (fig. 7) have been noticed:—

A. Pre-Cambrian gneiss, schist, with granitic and basic intrusions.

B. Mopunja Range series of coarse felspathic quartzites and purple shales resting upon a peneplaned Pre-Cambrian pavement.

These beds have a general dip of about 20°-25° to the north-east; the strike varying from north to east and then back to north as one travels from east to west.

C. Almost horizontal red sandstones, fine-grained quartzites, and some argillaceous beds, littoral in character and containing numerous fossils, which suggest a tentative "Ordovician" age for the beds.

D. Younger limestone series of thin horizontal beds capped by chalcedony, found resting unconformably on sediments of the Mopunja Range type.

In the accompanying block diagram (fig. 7) the relationships of the four series are set out in a simplified manner.

Acknowledgements.

We are indebted to Dr. C. Chewings, who suggested that these notes should be placed on record, and to the members of the Expedition, especially to Dr. H. K. Fry, who was particularly interested in the geology, and to Prof. T. Harvey Johnston, who located the "*Orthoceras*" horizon at Mount Ultim. Mr. C. O. Chalmers provided native guides and horses, and thus enabled us to visit several otherwise inaccessible spots. Finally, we are indebted to an Iliaura native, Akoambaka by name, who on our first arrival in the district explained the principal details of the physiography of his country by means of a relief map, voluntarily constructed in the sand of the creek bed.

Reference.

1. Brown, H. Y. L.: "Reports on Arltunga Goldfield . . . and Explorations North-east of Hart's Range, in South Australia." Parliamentary Papers, No. 1,353, Adelaide, 1897, pp. 5-8, and map No. 2.

NOTES ON SOME MISCELLANEOUS COLEOPTERA, WITH DESCRIPTIONS OF NEW SPECIES. PART VIII.

By Arthur M. Lea, F.E.S.
(Contribution from the South Australian Museum.)

[Read July 9, 1931.]

Family CURCULIONIDAE.

Mandalotus.

Since the key given in the Records of the South Australian Museum, on March 31, 1926, species of this genus have been dealt with as follows:—

1927. Lea, Proc. Linn. Soc., N.S.W., pp. 356-357.
1929. *L.c.*, pp. 528-533.
1931. Oke, Proc. Roy. Soc., Vic., pp. 181-190.

The species there dealt with, and the new ones described in the following pages, may be associated with the key in the following positions:—

B.	*pentagonoderes* Lea	G, *qq*.	*medianus*, n. sp.
C, *ddd*.	*leai* Oke, and *parentheticus*, n. sp.	G, *t*.	*canalicornis*, n. sp
		G, *u*.	*corrugicollis* Lea
C, *h*.	*sternocerus* Lea	G, *v*.	*melancholicus*, n. sp.
C, *n*.	*dolens* Lea	H.	*goudici*, n. sp.
D, *zz*.	*insignis*, n. sp.	I (or NN, *v*) ..	*femoralis* Lea
DD. *e*.	*rufipes* Lea	J, *m*.	*minusculus* Oke
DD, *eee*.	*egenus* Oke	J, *pp*.	*granicollis*, n. sp.
DD, *nnn*.	*fimbriatus* Lea	K (or YY) ..	*villosipes* Lea
DD, *r*.	*explanicollis* Oke	NN (or NNN)	*oculivorus*, n. sp.
F, *dd*.	*tuberipennis* Lea	NNN.	*modicus*, n. sp.
F, *l*.	*armicoxis* Lea	O.	*acanthocnemis* Lea, and *bryophilus* Oke
F, *m* (or NN, *ww*)	*octagonalis* Oke		
G, *q*.	*contortus*, n. sp. and *incisipes*, n. sp.	W.	*cinereus*, n. sp.

This leaves two species (excluding synonyms and others transferred to *Timareta)* for which no positions have yet been suggested, as their types are females.

M. imponderosus Lea. A minute species (1·5 mm.), from Queensland.

M. latus Lea. A wide, tuberculate, densely clothed species, from Tasmania.

The transverse arrangement of the prothoracic granules, often so exaggerated that the prothorax appears traversed by fine carinae, is a very distinctive feature of many species of the genus, and easily recognisable, although abrasion is sometimes necessary to see it. In the 1926 key, a special section, "G," was given for fourteen of them. Other species not previously referred to "G," but with transverse arrangement, are: *M. canalicornis*, n. sp., *contortus*, n. sp., *excavatus* Lea, *ferrugineus* Lea, *incisipes*, n. sp., *medianus*, n. sp., *melancholicus*, n. sp., *octagonalis* Oke, and *valgus* Pasc.

On fairly numerous species the middle coxae are armed, although to see the armature clearly it is sometimes necessary to twist the leg, or to view it from several angles, and a small amount of grease or dirt may easily obscure it.

On several species there is a shining ridge, but not a dentiform process. The species so armed, owing to the exigencies of tabulation, were not all associated together in the key. The following are also so armed:—*M. contortus*, n. sp., *ferrugineus* Lea, *dentipes* Lea, *medcoxalis* Lea, *medianus*, Lea, *octagonalis* Oke, *oculivorus*, n. sp., *oxyomus* Lea, (more a ridge than a tooth), and *valgus* Pasc.

I do not think the femora in any of the species could fairly be regarded as dentate, the apical incurvature in several species, from certain points of view, appears sudden, but the part before it is rather the abrupt termination of a swelling than a distinct tooth, and clothing may also cause deceptive resemblance to dentition. Although in figure 3 (especially on C and H) Mr. Oke has shown quite strong teeth, he nowhere mentions femoral dentition in his descriptions.

The tibiae are very distinctive on the males of many species, but it is usually necessary to examine them from several points of view, or even to detach them from the body (in the case of species with the inner side distinctive), to see their structure clearly; clothing and dried mud are also apt to disguise their features; so in the sketches given no clothing was shown.

In sending specimens of *M. goudiei*, Mr. Goudie called my attention to the fact that each of its claw-joints was apparently terminated by a single claw; this at first appears to be the case, but on close examination it may be seen that there are really two claws, very closely applied together; and they are very similar to those of the other species (H of the key) with the scape very thick (except in *M. nodicollis*, on which the claws are normal), *viz.*—*M. ammophilus*, *crassicornis*, *herbivorus* and *pondericornis*. This character was previously overlooked, except that for *ammophilus* it was noted: "Claws subsoldered together at base." On *M. howensis*, with a heavy scape, although less heavy than on the species of H, the claws are also approximate. On *M. acutangulus*, on which the scape is stouter than on most species, other than those of H, the claws are normal.

Mandalotus parentheticus, n. sp.

♂. Dark brown, antennae and tarsi paler, some parts obscurely darker. Densely clothed with dull brown and grey scales, becoming almost uniformly pale grey on under parts; in addition with stout and usually curved setae, on the elytra confined to a regular row on each interstice.

Rostrum with median carina normally concealed. Antennae moderately long. Prothorax moderately transverse, sides strongly rounded, derm concealed. Elytra subcordate, shoulders rounded, base wider than prothorax, interstices even except for feeble alternate elevation; punctures large, but appearing much smaller through clothing. Intercoxal process of mesosternum small, but obtusely conical. Metasternum very short. Basal segments of abdomen flattened in middle. Legs moderately long, front coxae touching. Length, 3·5-3·8 mm.

♀. Differs in being slightly more robust, intercoxal process of mesosternum unarmed, abdomen more convex, and legs slightly shorter.

Australia (Dr. W. Horn).

By the upper surface practically indistinguishable from *M. blackmorei*, but the mesosternum armed in the male, and both sexes distinct from those of that species by the front coxae in contact. The intercoxal process of the prosternum is but little produced, and is obtusely pointed, but in the key the species could only be placed in C, *ddd*, and associated with *M. vacillans*, in which the process is also rather feeble; but on that species the front coxae are distinctly, although not widely, separated. The clothing is also different, although not much reliance is to be placed on this. Both specimens have the derm brownish or castaneous, as may be seen where slight abrasions have occurred; the only parts that are apparently black are on the head. The scales on the prothorax are mostly pale, with five distinct dark lines from base to apex, the median straight, the others evenly

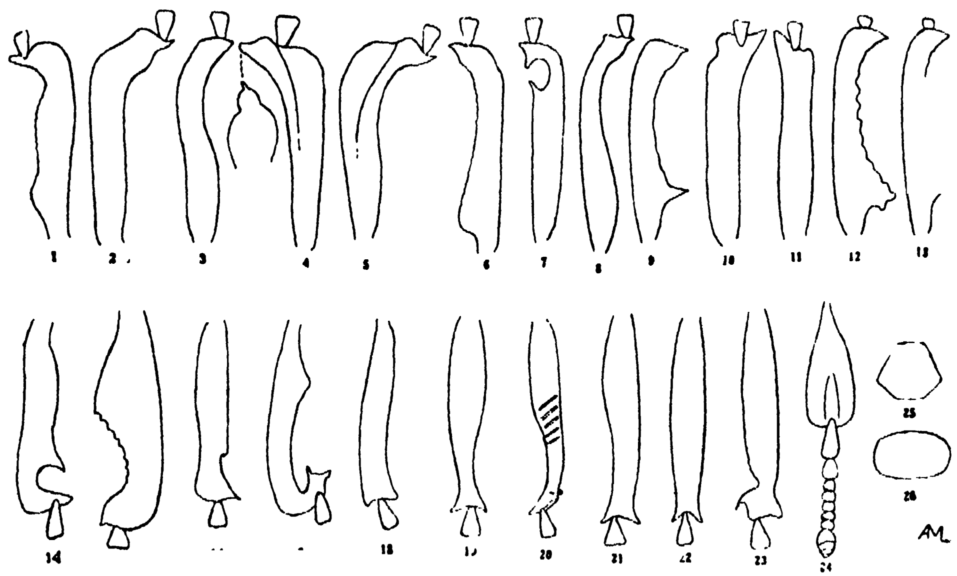
curved (less distinct on the female than on the male); on the elytra the paler scales are in the minority, and are irregularly distributed. The derm of the pronotum is entirely concealed, but feeble granules are indicated. There are no striking features on the legs, the right front tibia of the male has a minute denticle near the base, but it is not present on the left one.

Mandalotus insignis, n. sp.

Figs. 1, 14, 17, 18.

♂. Black, parts of antennae and tarsi obscurely reddish. Densely clothed with scales and setae.

Rostrum with median carina indicated throughout. Antennae moderately long. Prothorax slightly transverse, sides slightly increasing in width from base to apical third, and then rapidly narrowed to apex; with large, normally concealed granules. Elytra rough, base narrower than widest part of prothorax and unevenly arcuate; with rows of large punctures, distinct on sides, but almost or



EXPLANATION OF FIGURES.

1, front tibia of *Mandalotus insignis* Lea; 2, of *M. contortus* Lea, type; 3-5, of *M. contortus* from Barrington Tops; 6, of *M. melancholicus* Lea; 7, of *M. incisipes* Lea; 8, of *M. medianus* Lea; 9, of *M. acanthocnemis* Lea; 10-11, of *M. pentagonalis* Lea; 12-13, of *M. tibialis* Lea; 14, middle tibia of *M. insignis* Lea; 15, of *M. glaber* Blackb.; 16, of *M. canalicornis* Lea; 17-18, hind tibiae of *M. insignis* Lea; 19-20, of *M. medianus* Lea; 21, of *M. decipiens* Lea; 22-23, of *M. glaber* Blackb.; 24, antenna of *M. canalicornis* Lea; 25, intercoxal process of mesosternum of *M. niger* Lea; 26, variety of same. All without clothing.

quite concealed elsewhere; alternate interstices irregularly elevated, the third and fifth tuberculate. Basal segment of abdomen with a strong subconical tubercle on each side of middle, slightly nearer base than apex. Front coxae widely separated, but not quite as widely as middle ones; front and middle tibiae notched near apex, hind ones strongly bisinuate on lower surface, the apex incurved and bidentate. Length, 6·5-8·0 mm.

♀. Differs in being wider in proportion, elytral tubercles less conspicuous, basal segment of abdomen more convex and non-tuberculate, and tibiae not notched.

New South Wales: Bombala. Types, in Australian Museum.

Remarkably distinct by the bituberculate abdomen and tibiae of the male. In the key could be associated with *M. glaber* and *decipiens,* two polished black species, with very different tibiae. The clothing is so dense that the derm is everywhere concealed, and the type is rather dirty. To the naked eye it appears of a muddy-brown, but on close examination numerous small golden scales may be seen; the setae are numerous, and all the tibiae are fringed with long hairs. The third interstice on each elytron has a fairly large, round tubercle, crowning the apical slope, the fifth has a swelling at the basal third, and then curves outwards, and has three tubercles, one before the one on the third, and two beyond it, there is also a small posthumeral tubercle, invisible from directly above. The pronotum of the female appears to have four feebly elevated tubercles: two in the middle, and two at the base; on the male the two basal ones are very feebly indicated, but not the two median ones.

Mandalotus contortus, n. sp.

Figs. 2-5.

♂. Black, some parts paler, parts of antennae and tarsi obscurely reddish. Densely squamose and setose.

Rostrum with median carina obscured but traceable. Antennae moderately long. Prothorax slightly wider than long, angles rounded off, but sides subparallel in middle; granules conspicuously transversely arranged or subcarinate. Elytra at base narrower than widest part of prothorax, but quite as wide across the posthumeral swellings; with rows of large punctures, partly or entirely concealed by clothing; suture on apical slope, and parts of odd interstices elevated. Metasternum and two basal segments of abdomen widely and shallowly concave. Front coxae widely separated, middle ones each with a conspicuous tooth; front tibiae dilated and suddenly deflected at apex, with an obtuse notch near outer apex, the apex itself acute, middle tibiae strongly arched near apex and acutely pointed, hind tibiae rather strongly curved. Length, 7-9 mm.

♀. Differs in being more robust, elytra less strongly narrowed behind the posthumeral swellings, two basal segments of abdomen gently convex, middle coxae unarmed, front tibiae less suddenly deflected at apex, the other tibiae shorter, and all with shorter clothing.

New South Wales: Ebor (C. F. Deuquet), Barrington Tops (H. J. Carter).

A remarkable species. The prothoracic granules transversely arranged, dentate middle coxae, and front tibiae notched near apex, associate it with *M. dentipes,* from which it differs in being much larger, and elytra rougher. The front tibiae are much wider near apex, the external notch, although distinct, is rather shallow (it is less defined on the type than on the Barrington Tops specimen), and the tip is actually pointed (it is necessary, however, to examine the tibiae from several directions to see these particulars). The general outlines are much as those of *M. niger,* but the legs are very different. Seen from behind, the base of the elytra appears strongly trisinuate, but from directly above it appears almost evenly arched, with the shoulders clasping the base of the prothorax; the third interstice is distinctly elevated near the base, and again beyond the middle, the elevation abruptly terminated at the summit of the apical slope, so as to appear subtuberculate. From one direction the tooth on each middle coxa is seen to be flat, and wider than long, from another it appears as an acute spine. The hind tibiae are shining internally, with transverse granules or short ridges, denoting an approach to the numerous transverse ridges of *M. niger.* The clothing of the type is of a rather light brown, becoming paler on the under surface; on the upper surface there are many pale setae, in the majority on the pronotum, in the minority on the elytra, on the legs they are about evenly divided. The specimen from Barrington Tops has the clothing obscured by dried mud,

and the hairs on the lower part of the front tibiae are compacted, so as to appear to be fasciculate near the apex, its front tibiae are longer and more complicated at the apex (figs. 3-5) than on the type (fig. 2), but it was not made the type on account of its poor condition.

Mandalotus melancholicus, n. sp.

Fig. 6.

♂. Black, parts of antennae and tarsi reddish. Densely clothed with sooty or sooty-brown scales, interspersed with sloping or curved setae; on the elytra almost confined to a single row on each interstice; tibial fringes rather long.

Rostrum with median carina glabrous throughout. Antennae rather long. Prothorax slightly wider than long, sides rounded and widest slightly in advance of the middle, median line well defined; with flattened granules transversely arranged, or altered to short transverse or oblique ridges. Elytra slightly narrower than widest part of prothorax, base trisinuate, posthumeral prominences feeble and scarcely visible from above; with rows of large punctures, appearing much smaller through clothing, alternate interstices slightly raised. Metasternum and basal segment of abdomen rather shallowly depressed. Front coxae decidedly but not very widely separated, the middle ones almost twice as widely; front tibiae multigranulate internally, somewhat dilated towards base, and then suddenly narrowed to base itself, apex acutely pointed. Length, 5·5-6·5 mm.

New South Wales: Armidale (C. F. Deuquet). Two specimens.

The transverse or oblique arrangement of the prothoracic granules is not as pronounced as on the species referred to G, in the key, but regarding it as correctly placed there, it could hardly be associated with *M. abdominalis* (a much smaller and otherwise different species), as the basal segment of abdomen is punctate and clothed; passing that species it could only be associated with *M. crawfordi,* also much smaller and otherwise different. Regarding it as belonging to GG, it differs from *M. foveatus,* in the much less depth of the depression common to the metasternum and abdomen, that species also has quite rounded prothoracic granules; passing it, it could be placed with *M. albonotatus,* which is a smaller species, with very different clothing and granules. It seems better referred to G. The middle coxae could hardly be regarded as ridged, although shining along the middle; they are certainly not armed. On one specimen there is an obscurely pale ring on each femur, and a few pale scales on the under surface, but on the other the clothing is practically uniformly dark throughout. In general appearance it resembles *M. crudus* (with mesosternum armed), *arciferus* and *fimbriatus* (with abdomen carinated), and *piliventris* (with densely clothed abdomen). It is close to *M. corrugicollis,* but the transverse arrangement of the prothoracic granules much less conspicuous; on that species the ridges on the disc are all distinctly wider than the head, whereas on the present one there are many true granules, and no ridge is the width of the head; on the present species also there is an impressed median line, which is absent from *corrugicollis,* the front tibiae are more arched at the apex, and the clothing generally is darker.

Mandalotus incisipes, n. sp.

Fig. 7.

♂. Blackish, parts of antennae and tarsi reddish. Densely clothed with muddy-brown scales and setae, the latter on the elytra almost confined to a row on each interstice.

Rostrum with median carina exposed throughout. Scape rather long and thin (the rest of antennae wanting). Prothorax moderately transverse, sides gently rounded, median line slight; with flattened granules transversely arranged and often elongated. Elytra across posthumeral tubercles (which are rather

obtuse) the width of prothorax; with rows of large punctures, appearing much smaller through clothing; odd interstices slightly elevated. Metasternum and basal segment of abdomen with a rather deep excavation. Front coxae distinctly but not very widely separated, the middle ones each with an acute ridge, but not dentate, and separated more than the front ones, front tibiae suddenly notched near lower apex. Length, 6 mm.

New South Wales: Mittagong, in January (H. J. Carter). Unique.

In the key could be associated with *M. dentipes,* but the notch on the front tibiae is on the lower side of the apex, on that species it is on the upper side.,

Mandalotus medianus, n. sp.

Figs. 8, 19, 20.

♂. Blackish, parts of antennae and of legs obscurely reddish. Densely clothed with sooty-brown scales, variegated with stramineous, and interspersed with setae, on the elytra almost confined to a single row on each interstice.

Rostrum with median carina concealed towards base, but exposed in front. Antennae moderately long. Prothorax slightly transverse, sides rather strongly rounded; traversed by numerous fine ridges, becoming granules on sides. Elytra slightly narrower than prothorax, base trisinuate, posthumeral tubercles rather feeble; with rows of large punctures, appearing much smaller through clothing, alternate interstices feebly elevated, the apical slope somewhat rough but not tuberculate. Front coxae widely separated, not much less than the least distance between the middle ones, which are obtusely but fairly strongly dentate; front tibiae rather thin, moderately curved at apex, hind ones longer, shining internally and with transverse ridges across the median third. Length, 5-6 mm.

♀. Differs in being wider in proportion, prothoracic ridges shorter, two basal segments of abdomen gently convex, legs shorter, middle coxae unarmed, and hind tibiae without transverse ridges.

New South Wales (C. F. Deuquet).

In the key could be associated with *M. oxyomus,* from which it is distinct by the transverse ridges on the inner side of the hind tibiae, somewhat as on *M. niger.* It is somewhat like *M. contortus,* on a reduced scale, but the tibiae are very different. The paler scales are uniform on the head, form a distinct spot at the base of the third interstice on each elytron, clothe most of the sides, and form feeble spots on the rest of the upper surface; on the under surface and legs they cover about half the derm. The basal segment of the abdomen of the male is flattened and depressed in middle, the flattened space being almost glabrous, and margined externally by a curved line, extending from the tip of the segment to the middle of the coxa on each side, so that at first glance it appears carinated, although it is not really so. On the female the same space (although gently convex) is similarly bounded.

Mandalotus canalicornis, n. sp.

Figs. 16, 24.

♂. Black, parts of antennae and tarsi reddish. Densely clothed with scales, interspersed with stout setae.

Scape very stout, lower surface grooved on apical third. Prothorax moderately transverse, sides rather strongly rounded, granules transversely arranged and many altered to short ridges. Elytra across middle wider than prothorax, base arcuate, shoulders acutely produced; with rows of large, more or less concealed punctures; the odd interstices slightly elevated. Basal segment of abdomen depressed in middle. Front coxae almost touching, middle tibiae with a slight notch near lower apex, claws distinctly separated. Length, 4-5 mm.

♀. Differs in being slightly more robust, two basal segments of abdomen gently convex, legs slightly shorter, and middle tibiae feebly incurved near lower apex.

New South Wales: Armidale (C. F. Deuquet).

As the prothoracic granules are transversely arranged the species would not go as far as H (the *crassicornis* group) in the key; but in any case distinguished from all of that group by the normally separated claws (except *M. nodicollis*, which is structurally very different), and the transverse arrangement of the granules. Referring it to G, it could be associated with *M. acutangulus*, which has the scape thinner, but heavier than on other species of the genus (except those of H), and the front coxae more distant (about as far apart as the median ones of this species); on this species they are almost in contact. On *M. crawfordi, transversus,* and *setosus*, the scape is much thinner. The three specimens taken have the clothing obscured by dried mud, but on scraping some of this away the distinctive sculpture is revealed. The middle tibiae of the male have a slight subapical notch, but it is obscured by the clothing and invisible from most directions.

Mandalotus goudiei, n. sp.

♂. Black, parts of antennae and legs reddish. Densely clothed with sooty scales, with variable whitish or greyish markings, and interspersed with sloping setae, also varying in colour.

Rostrum short, median carina traceable throughout. Scape very stout, except the basal fourth. Prothorax moderately transverse, sides strongly rounded; with numerous round granules traceable through clothing. Elytra subcordate, shoulders rounded, considerably wider than prothorax across middle; with rows of large punctures, appearing much smaller through clothing, or quite concealed; alternate interstices very feebly elevated. Basal segment of abdomen flattened in middle. Front coxae touching, middle fairly close together. Length, 3 mm.

♀. Differs in being slightly more robust, two basal segments of abdomen gently convex, and slightly shorter legs.

Victoria: Black Rock, in May (J. C. Goudie). Numerous specimens obtained by sieving fallen leaves.

The smallest of all the species with heavy scape, and one of the most interesting of the genus. The claws at first appear to be single, but on close examination are seen to be close together (as on most of the species of H, in the key). On several specimens some of the body parts are reddish. The distribution of the paler scales is scarcely alike on any two specimens before me; on the type they cover most of the rostrum, form a distinct line on each side of the prothorax, and a few discal spots, cover about half of the elytra, of which the largest area begins on each shoulder, is obliquely dilated hindwards till it covers most of the apical slope, and cover much of the abdomen (there is a black median vitta on the three apical segments) and legs. On several specimens the shades are much less sharply contrasted, so that the surface appears rather feebly mottled; on several the pale line on each side of the prothorax does not extend the full length, but is sharply defined; the markings in the scutellar region are particularly variable. The intercoxal process of the mesosternum is briefly subconical, but as it is short, and alike on both sexes, the species could not fairly be referred to C, in the key.

Mandalotus granicollis, n. sp.

♂. Black, antennae and legs reddish. Rather densely clothed with brown scales, variegated with grey, and becoming sparse on under surface, most of which is shining; with sparse upright setae, more distinct on elytra than elsewhere; tibiae with rather long hairs on under surface, sparse on the front and middle pairs, denser and longer on hind ones.

Rostrum with median carina distinct only in front. Antennae moderately long. Prothorax slightly transverse, sides rather strongly rounded; with numerous small, shining granules. Elytra widest slightly behind shoulders, where the width is equal to that of prothorax, base evenly curved, without posthumeral tubercles; with rows of punctures, appearing fairly small through clothing; third and fifth interstices wider than the others, but not elevated above them. Basal segment of abdomen rather deeply depressed along middle. Front coxae touching, hind tibiae with a slight notch near outer apex, and several denticles (obscured by clothing) about inner apex. Length, 3·5 mm.

New South Wales: Mount Tomah, in October. Type (unique) in Mr. F. E. Wilson's collection.

The hind tibiae are conspicuously fringed, but as only the male is known, it cannot with certainty be associated with *M. inusitatus,* in which it is fringed in both sexes; it differs from the male of that species in the conspicuous median depression on the basal segment of abdomen, on each side of which there is a swelling (but not a tubercle or carina); passing that species, in the key, the feeble markings of the elytra are not sufficient to associate it with *M. maculatus* and *cordipennis* (two smaller species), passing which it is distinct from *M. gymnogaster* (also with a shining abdomen), *alpinus* and *muscivorus*, by the very different hind tibiae. It is perhaps nearer *muscivorus* than any previously named species. In some lights some of the scales have a faint golden gloss. The prothorax has numerous small shining granules, which apparently are normally without scales.

Mandalotus cinereus, n. sp.

♂. Reddish-brown, some parts almost black, antennae and tarsi paler. Densely clothed with almost uniform white or greyish-white scales, with numerous sloping or suberect setae, on the elytra confined to a single row on each interstice; front tibiae with numerous long hairs on under surface.

Rostrum with median carina shining throughout. Antennae long and thin. Prothorax moderately transverse, sides strongly rounded, granules normally almost concealed. Elytra slightly wider than prothorax, base evenly incurved; without posthumeral swellings; with rows of large punctures, appearing much smaller through clothing; interstices almost even. Two basal segments of abdomen flattened and minutely granulate in middle. Front coxae widely separated, tibiae rather thin, front and hind ones moderately arched at apex, and longer than the middle pair. Length, 4-5 mm.

♀. Differs in having the elytra wider, two basal segments of abdomen evenly convex, legs shorter, and front tibiae without special clothing.

New South Wales: Darling River flood of May and June, 1890 (R. Helms). Types, in Australian Museum; cotypes, in South Australian Museum.

With the general appearance of beach-frequenting species of *Timareta*, but with fairly distinct ocular lobes, and apical incurvature of prosternum well defined. The intercoxal process of the mesosternum, in the female, is wider than the coxae, but the 1926 key deals only with males; on the male of this species the process is scarcely perceptibly, if at all, wider than the coxae. In that key, passing *M. rufimanus* (which has much shorter legs and antennae and different clothing), it should probably be associated with *M. pallidus* and *blackmorei,* which are very differently clothed, and with shorter antennae. The prothoracic granules are feebly traceable before abrasion, but after this they are seen to be moderately large and obtuse, certainly not very minute (as on the species of V) or ordinarily distinct (as on the species of VVV). On two specimens many of the scales have a silvery gloss. Several females were taken, but only one male.

Mandalotus modicus, n. sp.

♂. Black, antennae and tarsi obscurely reddish. Densely clothed with muddy-brown, feebly variegated scales, and with sloping and mostly pale setae, on the elytra confined to a single row on each interstice; tibiae with rather long hair on under surface, denser, but not very dense, on the front pair than on the others.

Rostrum with median carina fine and distinct to base. Antennae comparatively long and thin. Prothorax moderately transverse, sides strongly rounded, median line moderately impressed; granules traceable through clothing. Elytra at widest the width of prothorax, conjointly arcuate at base, posthumeral swellings feeble; with rows of large punctures, appearing much smaller through the clothing, alternate interstices feebly elevated. Metasternum and basal segment of abdomen concave in middle. Front coxae widely separated, almost as widely as the middle pair, front tibiae moderately arched at apex. Length, 4·5-5·5 mm.

♀. Differs in having the elytra across middle considerably wider than prothorax, basal segments of abdomen evenly convex, legs shorter, front tibiae less curved at apex, and without special clothing.

Queensland: Maryborough, abundant in flood debris, in January (E. W. Fischer).

The middle coxae are slightly more distant than the front ones, but referring the species to NN, in the key, it could be associated with *M. raui*, which is a smaller species, with much more separated front coxae; it somewhat resembles *M. piliventris*, but the abdomen is without the long clothing, which is so conspicuous on the male of that species. Referring it to NNN, the prothoracic granules associate it with VVV, of which *M. subglaber* is a smaller and more sparsely clothed species; *M. angustus* is narrower, with front coxae much closer together and paler clothing; and *M. ciliatus* has much more conspicuous clothing on front and hind tibiae. It differs from *M. albonotatus* in the clothing at base of elytra and middle of abdomen; *M. angustipictus* is narrower, with thicker scape; and *M. similis* has smaller prothoracic granules and shorter tibiae; and all three species, which it somewhat resembles, have front coxae less widely separated. It is slightly more robust than *M. villosipes*, the depression on the under surface shallower, and less trough-like in character, and front coxae twice as widely separated. On many specimens the clothing is obscured by dried mud, but even on others in perfect condition it is only feebly variegated. On abrasion the elytral punctures are seen to be distinctly wider than the striae, before abrasion they appear to be much less, they are larger on the male than on the female. The tibiae of the male are shining and with small granules internally, the hind ones from one point of view appear to be feebly dentate at the middle, and gently incurved between there and the apex. On one female the deciduous mandibular processes are present and boomerang-shaped.

Mandalotus oculivorus, n. sp.

♂. Dark brown, antennae and legs reddish. Densely clothed with greyish scales and with sloping setae.

Rostrum without visible median carina. Antennae moderately long. Prothorax slightly transverse, sides evenly rounded. Elytra across middle distinctly wider than prothorax, base conjointly slightly arcuate, without posthumeral swellings; punctures appearing small through clothing, or quite concealed; interstices even. Two basal segments of abdomen very slightly depressed in middle. Front coxae distinctly but not widely separated, middle coxae obtusely dentate. Length, 2 mm.

South Australia: Smoky Bay, in July (H. C. Allen).

A minute species, of which two specimens were sent by Mr. Allen as eating the eyes of seed wheat in the ground, and doing considerable damage. The front coxae are not very widely, although distinctly, separated, and in the key the species might be associated with NN, from all the species placed there it differs in being much smaller. If referred to NNN, it could be associated with *M. microscopicus,* from which, as also from *M. inconspicuus,* it differs in having the scape longer and thinner, sides of prothorax more rounded, and elytra wider in proportion. *M. puncticollis* is an even smaller species, and has the front coxae touching. The middle coxae from some directions appear ridged, from another obtusely dentate, and the species is much smaller than any other having dentate or subdentate coxae. The clothing is almost uniformly grey, except that the elytra have a darkly-lined appearance, due to the flattening down of the setae on each interstice, but in some lights the elytral scales have a slight golden lustre. On a female sent with the type, the setae are more conspicuous and on the elytra are not flattened down. A female, from Adelaide, that appears to belong to the species, has the golden gloss distinct on the prothorax and elytra, and numerous small granules are distinctly traceable, on the type no granules are. Another female, from the Mount Lofty Ranges, has the elytra and most of the under surface black. It is probable, however, that the colour is variable, apart from the age of the specimens. On all four specimens the median carina of the rostrum, if present, is entirely concealed.

The females have the abdomen evenly convex, middle coxae simple, tibiae shorter, with shorter clothing (on the tibiae of the male the under surface is clothed with long hair, but it is rather sparse, even on the front pair).

Mandalotus acanthocnemis Lea.

Fig. 9.

Mr. Oke gave a figure of a front leg as of this species (p. 183, fig. E), showing the femur as dentate, and the tibia as having a fairly large triangular tooth. No doubt from certain directions the femur may appear dentate, but it is not so on the type; the tibial tooth is also more acute than as figured by him, but it is evidently variable (see his note at p. 181).

Mandalotus egenus Oke.

There are two specimens of this species, from Trafalgar, Victoria, in Mr. F. E. Wilson's collection. They agree well with the description, and I concur in Mr. Oke's opinion that a new section "DD, *ccc*. A transverse carina on second segment—*egenus*" would be required to fit it into the 1926 key.

Mandalotus excavatus Lea.

A specimen probably belonging to this species, is in the Macleay Museum, from the Clarence River. It is immature, as the general colour is castaneous, and the right mandibular process is still present. It is considerably larger (6 mm.) than the type, and the elevation on each side of the basal segment of abdomen is stronger, and produced upwards, so that it should be regarded as a tubercle; as such, in the key, instead of being placed with DD, it could be placed with D, and associated with *M. taylori,* which has very different prothoracic sculpture, and front coxae separated only half the distance.

Mandalotus ferrugineus Lea, var.

Two specimens, sexes, from Laureldale, New South Wales, apparently represent a variety of this species. They differ from the types in being larger (male 10 mm., female 8 mm.). The male has the abdomen partly abraded, exposing a curved ridge, hardly a carina, on the basal segment, arched forwards,

and a series of small granules on each of the third and fourth; the middle coxae are ridged but not as acutely as on the type (on the type from some directions they appear to be dentate); on partial abrasion its prothorax is seen to be transversely sculptured; the elytral tubercles and projections at the base are exactly as on the type. At first glance they appear to belong to *M. mirabilis*, but the male is without the long clothing of the under surface of that species, and differs in other respects.

MANDALOTUS DECIPIENS Lea.

Fig. 21.

A sketch is given showing the greatest curvature of the hind tibiae, for comparison with the sudden notch near the apex of that of the following species.

MANDALOTUS GLABER Blackb.

Figs. 15, 22, 23.

A sketch is given of the remarkable middle tibiae of this species, and two others of the hind ones from different points of view.

MANDALOTUS INTEROCULARIS Lea.

Numerous specimens from Cressy (Victoria) belong to this species, but are unusually large, 6·5-7·5 mm., excluding the rostrum; the carina on the basal segment of the abdomen of the male is of the same shape and position, but there is a narrow groove immediately anterior to it, so that it appears double (on typical specimens this is scarcely indicated), the legs are somewhat stouter, and the front coxae are slightly more widely separated.

MANDALOTUS IRRASUS Lea.

The female of this species differs from the male in being more robust, two basal segments of abdomen moderately convex, and legs somewhat shorter.

MANDALOTUS MEDCOXALIS Lea.

Additional males of this species, from Dorrigo, range in length 4-7 mm. The female differs from the male in having the two basal segments of abdomen feebly convex, the legs shorter, middle coxae unarmed, and hind tibiae less strongly curved.

MANDALOTUS METASTERNALIS Lea.

A male of this species, the second I have seen, from Teralba, New South Wales, in Mr. H. J. Carter's collection, is smaller (3·5 mm.) than the type, and has the tubercles of the metasternum smaller, although fairly distinct when viewed from the sides, the front tibiae are also less curved at the apex, and the granules of the hind tibiae are very indistinct.

MANDALOTUS NIGER Lea.

Figs. 25, 26.

I have previously[1] commented upon a specimen of this species as having the mesosternal process rounded, instead of slightly produced, and there is now another male, from Illawarra, before me in which it is transversely elliptic.

MANDALOTUS NODICOLLIS Lea.

A specimen of this species, in the Australian Museum, taken between Bourke and Wilcannia, on the Darling River, has the scales of the upper surface whitish-grey, and the setae unusually long. Most of the specimens previously seen were so densely covered with dried mud that the scales were entirely concealed.

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(1) Lea, Trans. Roy. Soc., S. Aust., 1911, p. 75.

Mandalotus pentagonalis Lea.

Figs. 10, 11.

Mr. Goudie has recently taken specimens of this species, at Black Rock, Victoria, by sieving fallen leaves. The type was immature, the fresh specimens are darker, and on several of them the scales on the upper surface are almost entirely black. The front tibiae of the male have a slight notch near the outer apex, but it is invisible from most directions. The female differs from the male in being more robust, mesosternum with intercoxal process transverse and unarmed, abdomen more convex, and legs shorter, with the front tibiae not notched.

Mandalotus rufipes Lea.

M. graminicola Oke.

The type of *M. rufipes* is a female, and was omitted from the 1926 key for that reason. Mr. Oke has recently sent us three paratype males of *M. graminicola*, which undoubtedly belong to the same species; he considered it could be associated with *M. bryophagus*, in the key, and in fact at first glance the front coxae appear to be in contact, but, examining them closely, there is seen to be a fine line between them (this is more pronounced on the female owing to her smaller coxae), so that, in the key, its real place is with *M. blackburni*, a much larger species without tubercles on elytra. Mr. Oke's specimens are slightly darker than the type, and the sides of the prothorax are less dilated; on two of them the median carina of the rostrum is scarcely traceable, on the other, owing to partial abrasion, it is distinct. The male is distinct from all the species with abdomen carinated, by its small size, and conspicuous elytral tubercles.

Mandalotus tenuis Lea.

At the foot of his description of *M. egenus*, Mr. Oke said he considered that this species should be placed in a separate genus, with *M. tenuis*, "as neither can be said to have ocular lobes." In my description of *tenuis* I noted: "The ocular lobes and the incurvature of the prosternum are unusually feeble." They are certainly very feeble, on both species, but in *Timareta* they are non-existent.

Mandalotus tibialis Lea.

Figs. 12, 13.

Some specimens of this species were sent from Moss Vale, New South Wales, as destructive to cabbages. The largest male measures 5 mm. in length. The female differs from the male in having the middle coxae unarmed, the front tibiae without the remarkable projection near the base, and the hind ones not multicarinate internally.

Timareta infortunata, n. nom.

Mandalotus pusillus Lea.

Mr. Oke has called my attention to the fact that in transferring *M. pusillus* to *Timareta*, I overlooked that Blackburn had previously[2] described a *T. pusilla*. I, therefore, propose the above name as a substitute.

Cryptoplus Er., Wiegm. Arch., 1842, I., p. 198.

Aolles Pasc., Journ. Linn. Soc., Zool., X., 1870, p. 450.

Cryptoplus was referred by Erichson to the Erirhinides, and as nearest to *Anoplus*. It was evidently unknown (except by description) to Lacordaire, who relying on Erichson's description and comments also placed it next to *Anoplus*,

(2) Blackburn, Proc. Linn. Soc., N.S.W., 1893, p. 265.

and treated it as the typical form of the Cryptoplides, which he placed as the third "Groupe" of the Erirhinides. It was unknown to Pascoe, Blackburn and others, all of whom allowed it to remain in the Erirhinides.

Although when dealing with clawless, and apparently clawless, Curculionidae of Australia I considered the genus, not actually knowing it, and having searched for it many times, especially amongst the Tasmanian weevils before me, without success, no reference was made to it.

Early in 1931 I appealed to Dr. Walther Horn for information as to the antennae and tarsi of the type; he informed me that it was in the Zoological Museum of the Berlin University, where Mr. Korschefsky examined it and stated "that the funicle has only six joints and the tarsi only one claw." Subsequently Prof. Dr. Kuntsen, of the institution, courteously sent it to me for examination.

On arrival in Adelaide it was at once apparent that it belonged to the genus *Aolles*. This genus I at one time considered as a subgenus only of *Haplonyx* (an opinion evidently shared by Chevrolat), but subsequently, on account of the great number of its species, treated as of generic rank. It is, in fact, doubtful if *Cryptoplus* should be regarded as more than a subgenus of *Haplonyx*, and it is certain that it belongs to the Haplonycides, and not to the Erirhinides.

EXPLANATION OF FIGURES.

27, side view of head and rostrum of *Cryptoplus perdix* Er.; 28, of *C. orbiculatus* Lea; 29, of *C. rostralis* Lea.

CRYPTOPLUS PERDIX Er.

Aolles maculipennis Lea, var.?

Fig. 27.

Two of the characters mentioned by Erichson are misleading. He described the funicle as seven-jointed and the rostrum as straight.

The type is pinned and unset, and it is difficult from most directions to see the funicle sufficiently clearly to count the joints, but from one direction and in a good light, it was quite distinctly seen to be six-jointed only (as it is on all the species previously referred to *Aolles*, and this character, with the apparently triarticulate tarsi, were relied upon by Pascoe as entitling that genus to separation from *Haplonyx)*. Its rostrum is also not quite straight, although twice noted as "rectum," the curvature is certainly very slight, but is sufficiently distinct from the sides; on most species of the genus, however, it is quite straight, although on a few it is slightly more curved and thinner than on that species. It is also somewhat longer and thinner on the female than on the male of all the species, of which both sexes are before me, and there is sometimes a faintly increased curvature on the female. From above it appears considerably wider than from the sides. I have carefully compared the type with all of the 33 species referred to *Aolles* (except *nuceus*, not represented in the Adelaide collections, but which may belong to *rubiginosus)*, and, although quite an ordinary looking species, it does not agree perfectly with any of them.

The markings of the upper surface are nearest to those of *C. variegatus*, whose rostrum is black and quite straight, and practically identical with those of a male of *C. maculipennis*, whose rostrum is quite straight on the under surface and feebly curved at the apex on the upper surface (most specimens of *maculipennis*, however, do not resemble it very closely). *C. nigrirostris (Haplonyx)* is also very close, but on all the many specimens of that species before me (some

smaller and some larger than the type of *perdix)*, there is a postmedian fascia on the elytra, and the rostrum is quite straight and black. *C. ornatipennis* (of which I have taken a specimen at Hobart) is very close to, if not a variety of, *nigrirostris*. *C. intermedius* has a more distinctly curved rostrum (but which is black), and is a decidedly narrower species. *C. pictus* has a feebly curved black rostrum, but has striking markings on elytra. *C. rostralis* is a larger, fasciate species, with a longer and more curved rostrum. All the other species are very distinct from it.

CRYPTOPLUS ORBICULATUS Lea *(Aolles)*.

Figs. 28, 30-32.

Three photomicrographs are given to show the antennae and legs of this common species, also an outline figure of the side of the head and rostrum.

EXPLANATION OF FIGURES.

30, front leg of *Cryptoplus orbiculatus* Lea; 31, middle leg; 32, antenna.

CRYPTOPLUS ROSTRALIS Lea *(Aolles)*.

Fig. 29.

On this species the rostrum is longer and more curved than on any other species before me.

MENIOS.

As previously noted[3] the character of the "Metasternum longer than the first abdominal segment" of the original species, is not to be depended upon, and on each of the four species here described, it is slightly shorter than that segment.

Menios spurcus, n. sp.

♂. Black, some parts blackish-brown, antennae and tarsi paler. Densely clothed with soft, muddy-brown scales, in places with obscure markings, and interspersed with numerous stout, erect setae, some of which form fascicles.

Rostrum about the length of prothorax, basal two-thirds densely clothed, elsewhere subopaque and with small punctures. Antennae inserted about two-fifths from apex of rostrum. Prothorax distinctly transverse, sides strongly rounded, apex less than half the width of base; with dense, concealed punctures. Elytra oblong to near apex, distinctly wider than prothorax; with rows of large, partly concealed punctures. Femora rather strongly and acutely dentate; tibiae thin. Length, 4·8-5·2 mm.

♀. Differs in having rostrum slightly longer, clothed only on basal third, elsewhere shining and with small punctures, and basal segment evenly convex, instead of flattened in middle.

North Australia: Darwin (G. F. Hill).

(3) Lea, Trans. Roy. Soc., S. Aust., 1913, p. 285.

A dingy species, somewhat like *M. nebulosus*, but with facets of eyes slightly smaller, elytral fascicles differently disposed, the setae more numerous, and lateral interstice not glabrous. *M. sordidatus* has clothing of much the same colour, but more evenly plating the surface, and with different fascicles. On each of two specimens there is a fairly distinct dark fascia, across the middle of the elytra, but narrowed at the suture, and some still more obscure subapical spots; from two others markings are practically absent. There are some scattered setae on the prothorax, but four distinct fascicles across middle, four less distinct ones at base (these appear to be easily abraded), and two feeble ones at apex; on the elytra scattered setae are rather numerous, and there are three or four feeble fascicles on the third interstice, and a few still more feeble ones elsewhere.

Menios ferrugineus, n. sp.

♀. Blackish, antennae and tarsi reddish. Densely clothed with rusty-brown scales, in places mottled with sooty-brown; with stout setae scattered about, and forming numerous fascicles.

Rostrum not very stout, apical two-thirds shining and with small punctures. Antennae inserted about two-fifths from apex of rostrum. Prothorax moderately transverse, apex suddenly narrowed and less than half the width of base; with dense, concealed punctures, and a short median carina. Elytra much wider than prothorax, parallel-sided to beyond the middle; with rows of large, setiferous, partly concealed punctures. Basal segments of abdomen evenly convex. Femora strongly and acutely dentate, tibiae thin and compressed. Length, 5·5 mm.

Queensland: Kuranda (F. P. Dodd). Unique.

At first glance apparently belonging to *Tychreus*, but with the coarsely faceted eyes of *Menios*. There are six fascicles on the prothorax, of which the two median ones are more distinct and supported on larger tubercles than the others; on the elytra there are three fairly large fascicles on the third interstice, three smaller ones on the fifth, and a few still smaller ones elsewhere. The dark mottlings of the elytra are almost confined to the apical slope and middle of sides, and on the prothorax to the sides, they also form obscure rings on the legs.

Menios poecilopterus, n. sp.

Blackish, antennae and tarsi reddish. Densely clothed with rusty-brown scales, mottled with paler and darker ones, and with numerous short setae, in places compacted to form feeble fascicles or clusters.

Rostrum about the length of prothorax, not very thin, basal half clothed; elsewhere subopaque and with dense and small punctures. Antennae inserted slightly nearer apex than base of rostrum. Prothorax moderately transverse, sides strongly rounded, apex about half the width of base; with dense, concealed punctures. Elytra parallel-sided to near apex; with rows of setiferous punctures indicated through clothing, alternate interstices slightly elevated. Basal segment of abdomen slightly flattened in middle. Femora strongly and acutely dentate, tibiae rather thin. Length, 5 mm.

Queensland: Cairns (J. A. Anderson). Type (unique), in Queensland Museum.

Near *M. albifasciatus* and *spurcus*, and like those species its fascicles are few in number and ill-defined. In many respects they approach *Evaniocis*, but the species of that genus have the club essentially different. It has the general appearance of *Phlaeoglymma mixta*, but differs from the genus in having the mesosternal receptacle more elevated and cavernous, and eyes with coarser facets. The pale scales on the upper surface are usually in small spots, of which several form a curved line on each shoulder, and an irregular fascia crowning the apical slope; the dark spots are still smaller in area, and many are due to clusters of

blackish setae; of the setae there are many on the prothorax, compacted to form six clusters, scarcely fascicles; on the elytra the black setae form fairly long spots on the third interstice, near the base, and at the middle, on the second before the middle, and some irregular clusters before and behind the pale humeral spots; on the pale spots some of the setae are almost white. There is a single line of scales on the inner side piece of the mesosternum. The type is probably a male.

Menios papuensis, n. sp.

♂. Blackish, some parts obscurely paler. Densely clothed with rusty-brown scales, variegated with paler and darker ones, and with numerous setae, in places forming fascicles.

Rostrum moderately stout, distinctly curved, the length of prothorax; with dense and rather small, but sharply-defined punctures, concealed only about basal third. Antennae inserted slightly nearer apex than base of rostrum. Prothorax moderately transverse, sides strongly rounded, apex less than half the width of base; with large, setiferous punctures, and smaller concealed ones. Elytra much wider than prothorax, parallel-sided to near apex; with rows of rather large, rough, partly concealed punctures; many of the interstices with small granules, more numerous on the ninth than on the others. Basal segment of abdomen flattened in middle. Femora stout, strongly and acutely dentate, tibiae somewhat compressed. Length, 7 mm.

Papua: Mount Lamington (C. T. McNamara). Unique.

In the table of allies of *Chaetectetorus*[4] this species could only be referred to *Acrotychreus* or to a new genus; but, on the only known species of that genus, the femora are more clavate, more strongly dentate, and the tibiae are strongly arched at the base; the general appearance also is very different. The upper surface is strikingly like that of *Pseudometyrus antares*, but the rostrum is wider, moderately curved, and the facets of the eyes are larger. The species of *Metyrus* have the rostrum stouter, facets of the eyes smaller, and tibiae wider. The metasternum is slightly shorter than the following segment, and as this is the only character which separates it from the original species of *Menios*, and the difference between the two sclerites being variable, it appears desirable to refer it to that genus, now first recorded from New Guinea. On the upper surface the scales are irregularly mixed, no fairly large patch being of any one shade of colour, although the fascicles are mostly composed of dark setae; on the prothorax there are two rather feeble clusters of setae in front, and four distinct fascicles across the middle; on the elytra there are two fairly large fascicles, supported on tubercles, on the third interstice (one near the base, the other postmedian) and a smaller one behind, four small ones on each side of the suture (the largest crowning the apical slope), three small ones on the fifth, and very feeble ones on the seventh. On the sides of the prothorax, invisible from above, the lower margins of the punctures appear as small, shining granules.

MENIOS NEBULOSUS Lea.

Two specimens from South Australia (Mount Lofty and Kangaroo Island) appear to belong to this species, but differ from the types in being slightly larger and with more white scales on the elytra; these form oblique vittae from the shoulders to near the suture at the basal third, and a moderately distinct fascia at the summit of the apical slope; on the Island specimen the sides of the prothorax and base of elytra are clothed with fawn-coloured scales. In general they are strikingly close to *Phlaeoglymma mixta*, but have the mesosternal receptacle cavernous, instead of open.

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(4) Lea, Proc. Linn. Soc. N.S.W., 1909, p. 594.

Menios alternatus Lea.

A male from Dunk Island, in the Queensland Museum, is paler than usual, and has a fairly well-defined white V on the elytra, touching the suture at the basal third, and almost touching the shoulders; there is a fairly large irregular dark spot on each elytron. The fascicles of its upper surface are ill-defined, being represented only by a few feebly compacted scales.

Menios internatus Pasc.

Mr. F. E. Wilson has reared specimens of this species from stalks of the waratah (*Telopea speciosissima*), at Mount Victoria (New South Wales).

Metyrculus sordidus, n. sp.

♂. Black, antennae and tarsi reddish. Densely clothed with sooty-brown and paler scales, and with numerous short, stout, sloping setae.

Rostrum stout, slightly shorter than prothorax, dilated to apex, densely clothed throughout. Antennae inserted slightly nearer base than apex of rostrum. Prothorax very little wider than long, sides rather strongly rounded; punctures concealed. Elytra much wider than prothorax, parallel-sided to near apex; with rows of large punctures, appearing small through clothing. Mesosternal receptacle briefly Y-shaped. Metasternum and basal segment of abdomen subequal, the latter faintly depressed in middle. Femora not very stout, edentate. Length, 3·5 mm.

Queensland: Bowen (Aug. Simson). Unique.

The mesosternal receptacle, somewhat elevated and keeled, associates this species with *M. mediofasciatus*, which is a much larger and otherwise different species; it is about the size of *M. trimaculatus*, but the elytra are not bimaculate at the median third, and the scales on the metasternum are not individually distinct; on *M. cinerascens* the mesosternal receptacle is U-shaped. Most of the scales on the upper surface are sooty-brown, with some pale ones on the scutellum and near the shoulders, and some small, inconspicuous spots elsewhere; on the under surface, both of body and of legs, most of the scales are whitish. The setae nowhere form fascicles, or even clusters, and they are usually of the same colour as the scales amongst which they are placed; they form a regular row on each elytral interstice.

Metyrculus semicircularis, n. sp.

♂. Dark brown, antennae paler. Densely clothed with slaty-grey, sooty, and white scales, and with numerous short, sloping setae, in places compacted to form fascicles or clusters.

Rostrum wide, slightly shorter than prothorax, sides somewhat dilated to apex, densely clothed throughout. Antennae inserted almost in middle of rostrum. Prothorax very little wider than long, sides gently rounded, apex about half the width of base; punctures concealed. Elytra much wider than prothorax, parallel-sided to beyond middle; with series of large punctures, appearing much smaller through clothing, or quite concealed. Mesosternal receptacle briefly U-shaped, base not keeled. Femora edentate. Length, 2·0-2·5 mm.

Torres Straits: Cornwallis and Mabuiag Islands (C. T. McNamara).

Allied to but slightly smaller than *M. sinuatus*, and with more pale scales on the pronotum, the base of the mesosternal receptacle is also slightly smaller (much as that of *M. cinerascens*). Most of the scales on the upper surface of the Cornwallis Island specimens are slaty-grey, with some small dark spots, sometimes sooty, on the sides of the elytra; on the prothorax there is a distinct white semicircle, its ends touching the elytra near the shoulders, and less distinct pale markings on the apical sides; on the elytra there are small white spots about the

shoulders, crowning the apical slope, and about the apex; there are some dark markings on the legs, but most of the scales on the under parts are white. The setae are mostly dark, and form feeble clusters on the prothorax, and two fairly distinct fascicles on the third interstice on each elytron. On the Mabuiag Island specimens the semicircle on the pronotum is present, but less distinct; on one of them the pale markings of the elytra are more conspicuous, and form a rather wide but not uniform fascia across the summit of the apical slope (to a certain extent this specimen resembles *Achopera bifasciata*, but that is a decidedly narrower species, with a larger mesosternal receptacle); on another they are less distinct; on each of them, in addition to the fascicles on the third interstice, there is a small one on the second, and another on the fifth. All the specimens taken appear to be males.

A specimen from Cairns, in the Macleay Museum, appears to belong to the species, but is slightly larger (2·8 mm.), the semicircle on the prothorax is feeble (but can be traced); white spots are absent from the elytra (or very feebly defined), most of their scales being pale slaty-grey, with some irregular dark spots on the sides. Where its scales have been abraded the derm is seen to be reddish, probably from immaturity.

Metyrculus postscutellaris, n. sp.

♀. Black, antennae and tarsi reddish. Densely clothed with pale rusty-brown scales, becoming mouse-coloured on most of apical half of elytra, mostly brown on abdomen, but with some blackish and whitish ones, whitish and brown on metasternum; elytra with a row of inconspicuous, short, sloping setae on each interstice, but with a distinct white one in each seriate puncture.

Rostrum rather wide, the length of prothorax, quite straight, basal third clothed, elsewhere shining and with small but distinct punctures. Antennae inserted slightly nearer apex than base of rostrum. Prothorax distinctly transverse, sides strongly narrowed near apex, which is less than half the width of base, with five fascicles, supported on slight tubercles, transversely placed slightly in advance of middle, the median one slightly larger and with paler scales than the others; with dense, concealed punctures. Elytra closely applied to and no wider than prothorax, parallel-sided to beyond the middle; with rows of fairly large punctures, and with a few small (and usually concealed) granules; with a small granulate swelling immediately behind the scutellum. Mesosternal receptacle with emargination short and wide. Metasternum slightly shorter than first segment of abdomen, but longer than second. Femora stout, edentate, and strongly grooved, tibiae compressed. Length, 6·5 mm.

♂. Differs in having rostrum slightly shorter and wider, opaque, and with crowded punctures, antennae inserted slightly nearer the apex of rostrum, and two basal segments of abdomen flat in middle, instead of convex.

Queensland: Cairns (Dr. W. Horn, from H. Hacker, and Lea collection, from Dr. E. W. Ferguson).

Somewhat larger and distinctly wider than any other species of the genus; to a certain extent its appearance is suggestive of *Tychreus*, but the femora are edentate and strongly grooved. There are no true fascicles on the elytra, but the post-scutellar elevation is very distinct. The head and rostrum of the male being badly abraded, and only part of one antenna left, the female was made the type of the species.

Metyrculus mediofasciatus Lea, var.

Two specimens from Ebor (New South Wales) agree in many respects so perfectly with the types of this species, that they can hardly represent more than a variety of it; but they have the median fascia of the elytra snowy-white (with a few darker scales and setae in it), on the abdomen and legs nearly all the scales

are also snowy-white, and on the abdomen they are nearly all distinctly longer than wide (subsetose in character, although adpressed). On the types of the species the abdominal scales are all brown and much shorter, most of them being quite circular. A specimen from Dorrigo has the elytral fascia white, with the abdominal scales equally thin, but of a darker colour than on the Ebor specimens.

METYRCULUS BIMACULATUS Lea, var. C., n. var.

A male from Eccleston (New South Wales) is larger (6 mm.) than usual, and the white spot on each elytron is broken up into two narrow strips on the fourth and sixth interstices, the part on the sixth being slightly nearer the base than the part on the fourth. A somewhat similar, but slightly larger specimen, was in the Blackburn collection, the spot on its right elytron is divided as on the Eccleston specimen, but not that on the left.

PSEUDOMETYRUS CYLINDRICUS Lea.

A female of this species, from Tasmania, differs from the male (the only sex hitherto known), in having the rostrum parallel-sided, shining, and with minute punctures from apex to behind antennae, and then rapidly increasing in width to base; the antennae are also inserted nearer the middle, and the abdomen is more convex.

PSEUDOMETYRUS BICAUDATUS Lea.

A specimen of this species from Dorrigo (New South Wales), differs from the type in having most of the elytral scales (except those forming fascicles) dark green, with a slight metallic gloss; a few of the prothoracic scales are also somewhat greenish, but most of them are deep black.

PSEUDOMETYRUS ANTARES Er.

A male in the Queensland Museum (labelled as taken in January, 1893, by C. J. Wild, on Mount Tambourine), appears to belong to this species, but differs from Tasmanian specimens in being somewhat larger (10 mm.).

Achopera alba, n. sp.

♀. Black. Densely clothed with whitish scales, interspersed with stout, depressed, whitish setae, except that on the prothorax some are brownish.

Rostrum about the length of prothorax, not very wide in front, but dilated from insertion of antennae (slightly nearer base than apex) to base; basal third densely clothed, elsewhere glabrous (except for a few setae on sides), highly polished and with a few small punctures. Prothorax moderately transverse, sides rather strongly rounded, apex more than half the width of base; punctures concealed. Elytra distinctly but not much wider than prothorax, base distinctly trisinuate, sides parallel to beyond the middle; with rows of large punctures appearing narrowly oblong through clothing. Mesosternal receptacle rather strongly elevated, base short. Metasternum slightly longer than basal segment of abdomen along middle, twice as long at sides. Femora not very stout, edentate. Length, 8 mm.

Western Australia: Eradu (J. Clark).

This and the following species have a strong general resemblance to *A. isabellina,* but the scales are consistently larger, and with a somewhat woolly appearance, they may, however, be at once distinguished by the elytral setae; on that species they are thin and true setae; on this they are much wider, and appear like larger scales, set in rows on the interstices; there are other differences in the rostrum and antennae; *isabellina,* so far, is only known from Queensland.

Achopera subalba, n. sp.

♂. Blackish, antennae and tarsi reddish. Densely clothed with whitish scales, with scattered brownish ones of various shades, but not forming distinct spots, and interspersed with stout, decumbent setae.

Rostrum the length of prothorax, rather wide, sides gently incurved to middle, where the width is slightly more than the distance separating eyes; basal third densely clothed, elsewhere moderately clothed, but punctures traceable. Scape inserted nearer base than apex of rostrum, and much shorter than funicle. Prothorax moderately transverse, sides strongly rounded; punctures concealed. Elytra oblong-cordate, distinctly wider than prothorax, base incurved only at scutellum; striae distinct, but punctures entirely concealed. Length, 5 mm.

North Western Australia: Wyndham, in January (J. Clark).

In general appearance like a small specimen of the preceding species, but with a fine longitudinal impression on the rostrum at its narrowest part. The two species may be distinguished as follows:—

A. subalba.	*A. alba.*
Elytra at base not incurved near each shoulder.	Elytra trisinuate at base, as a result the shoulders slightly clasp the base of prothorax.
Prothoracic scales large, and not mixed with setae.	Prothoracic scales slightly smaller and mixed with setae, which, although depressed, are distinct by their darker colour.
Scales of under surface large and almost uniform.	Scales of under surface smaller, denser, and mixed with stout, adpressed setae.

Achopera pictiventris, n. sp.

♂. Blackish, antennae and tarsi reddish. Densely clothed with sooty scales, with pale markings, and interspersed with depressed setae.

Rostrum moderately stout, slightly shorter than prothorax, sides gently incurved to middle; basal half densely clothed, apical half almost glabrous and with dense punctures. Scape inserted slightly nearer base than apex of rostrum, and much shorter than funicle. Prothorax moderately transverse, gently convex, sides strongly rounded, apex less than half the width of base; with dense, concealed punctures. Elytra at base not much wider than widest part of prothorax, not quite parallel-sided to near apex, base distinctly trisinuate; with rows of large punctures, appearing much smaller through clothing, or quite concealed, but striation evident. Mesosternal receptacle with base large, and emargination very short. Metasternum much shorter than basal segment of abdomen, and slightly shorter than second; basal segment with a wide, shallow depression, continued on to second. Femora edentate. Length, 4-5 mm.

♀. Differs in having rostrum thinner, less of the base clothed, elsewhere shining and with smaller punctures, two basal segments of abdomen evenly convex, and legs slightly shorter.

Western Australia: Perth (H. M. Giles).

A dingy species, with distinctive abdominal clothing, which might, with equal propriety, be referred to *Achopera* or *Metyrculus*, the character of the metasternum, longer or shorter than the following segment, formerly used in the table of allies of *Chaetectetorus*, is not to be relied upon. As in its flatter body, widely concave abdomen of male, abdominal clothing, and depressed setae of upper

surface, it agrees more with the species of *Achopera,* it is referred to that genus; from *A. lachrymosa* it differs in being wider and metasternum decidedly shorter. On *A. sabulosa* the metasternum is quite as short, but the clothing is very different. *A. maculata* is a narrower species, with very different abdominal clothing. In appearance it is fairly close to some varieties of *Meniomorpha inconstans,* but the rostrum is much shorter. From *Metyrculus bimaculatus* and *mediomaculatus,* which have pale median spots on the elytra, it is at once distinguished by the abdominal clothing. The scales on the upper surface are mostly sooty, with some feeble brownish spots on the sides of prothorax and apical half of elytra; there is, however, a small, conspicuous white spot, on the third and fourth interstices on each elytron, at the basal third; on the metasternum there is a sooty vitta on each side of the middle; on the abdomen of the male a wide median portion has sooty scales, the sides with whitish ones, on the legs the scales are whitish and sooty; on the female, the whitish median line of the metasternum is continud along the two basal segments of abdomen.

Achopera microps, n. sp.

♂. Dark brown, legs and antennae reddish. Densely clothed with chocolate-brown and stramineous, or whitish, scales, interspersed with sloping setae.

Rostrum not very thin, the length of prothorax; densely clothed except at muzzle, which is shining and with small punctures. Scape inserted in middle of rostrum, much shorter than funicle. Prothorax as long as wide, sides gently rounded, apex half the width of base; punctures concealed. Elytra not much wider than prothorax, almost parallel-sided to near apex, base gently trisinuate; with rows of large, subquadrate punctures, appearing much smaller through clothing, or quite concealed, but striation distinct. Mesosternal receptacle rather solid, emargination short. Metasternum distinctly longer than basal segment of abdomen, the latter gently depressed in middle. Femora edentate. Length, 3·5-4·0 mm.

♀. Differs in having the rostrum thinner, apical half shining and with small punctures, and basal segments of abdomen gently convex.

New South Wales: Dorrigo (W. Heron). Two specimens.

A narrow, depressed species, with general outlines much as those of *A. lachrymosa,* but with different scales and setae; it is narrower than *A. uniformis,* and the metasternum is longer. The prothoracic markings resemble those of some specimens of *A. alternata,* but the elytral interstices are even. The eyes are smaller, and the tarsi narrower than is usual in the genus. At first glance it looks somewhat like *Ephrycinus pilistriatus,* but is flatter, with much less conspicuous setae. On the male the scales on the prothorax are mostly pale, with a large, irregular, medio-basal brown patch; on the elytra the pale markings cover about one-fourth of the surface, in irregular spots and asymmetrical fasciae; on the female the brown patch on the prothorax is broken up into four spots, and the pale markings on the elytra cover less of the surface; on each of them the clothing of the under parts is almost uniformly pale. The setae are usually of the same colour as the scales, on the elytra they form a regular row on each interstice.

Achopera multimaculata, n. sp.

♂. Blackish, antennae and tarsi reddish. Densely clothed with sooty-brown and obscurely whitish scales, interspersed with short, sloping setae.

Rostrum rather wide, slightly shorter than prothorax; densely clothed, except at tip, which is shining and with small punctures. Scape inserted slightly nearer base than apex of rostrum, and much shorter than funicle. Prothorax not much wider than long, apex more than half the width of base; with dense, concealed punctures. Elytra distinctly wider than prothorax, parallel-sided to near apex,

base moderately trisinuate; with rows of large punctures, appearing narrow through clothing, or quite concealed. Mesosternal receptacle large, with a basal stem, emargination short. Metasternum slightly longer than basal segment of abdomen, the latter shallowly depressed in middle. Femora stout, edentate. Length, 4·5 mm.

Torres Straits: Murray Island (A. M. Lea). Unique.

A multimaculate species, structurally like *A. lachrymosa,* except that the elytral striae are more pronounced. *A. uniformis* is wider, the dark clothing occupies less of the surface, and the setae are more distinct. The elytra are wider in proportion than those of the preceding species, the metasternum is but little longer than the following segment, and the eyes are slightly larger. The scales on the prothorax are mostly dark, with several small pale spots, of which three are conjoined to form a short, mediobasal Y; on the elytra the pale spots are small, numerous, asymmetrical, and two or more are sometimes transversely conjoined; on the under surface the scales are pale, but some of the setae are dark. The setae of the upper surface are distinct only from the sides, they form a regular row on each interstice.

Achopera longiventris, n. sp.

♂. Blackish-brown, some parts obscurely paler, antennae reddish. Sparsely clothed with stramineous and brownish scales, and with short, sloping setae.

Rostrum moderately stout and curved, the length of prothorax; sparsely clothed even at base, and with comparatively large and dense punctures, except on a narrow, shining median line. Scape inserted slightly nearer base than apex of rostrum, and much shorter than funicle. Prothorax not much wider than long; with dense and comparatively large punctures. Elytra slightly wider than prothorax, parallel-sided to near apex, base truncate; with rows of large, quadrate or oblong punctures, usually wider than interstices; the latter each with a single row of setiferous punctures. Mesosternal receptacle rather large, with a short basal stem. Metasternum and two basal segments of abdomen with rather large punctures; the former much shorter than basal segment (which is depressed in middle), and scarcely as long as the second, second slightly longer than third and fourth combined, and much longer than fifth. Femora not very stout, edentate. Length, 5 mm.

Queensland: Prairie, in October (— Chisholm). Unique.

A narrow, flat species, with two basal segments of abdomen unusually long. The general outlines are somewhat as on large specimens of *A. lachrymosa,* but the clothing is much sparser, many of the elytral punctures are not at all concealed, and are even more distinct than on *A. xanthorrhoeae,* which is a smaller species, with conspicuous markings. Although its clothing is much sparser than on all other species of the genus, the type does not appear to be abraded; there are several small spots of pale scales on the elytra; the setae are distinct only from the sides, they form a regular row on each interstice; on the under surface each of the punctures contains a seta, which seldom arises above the general level.

Achopera subcylindrica, n. sp.

Dark brown, antennae and tarsi reddish. Densely clothed with chocolate-brown and pale stramineous scales, interspersed with short, sloping setae.

Rostrum wide, shorter than prothorax; tip glabrous and with dense punctures. Scape inserted nearer base than apex of rostrum, and much shorter than funicle. Prothorax slightly longer than wide, apex almost the width of base; with dense, concealed punctures. Elytra not much wider than prothorax, parallel-sided to

near apex; with rows of large punctures, partly concealed by clothing, but striation distinct. Mesosternal receptacle rather stout. Metasternum and basal segment of abdomen subequal. Femora stout, edentate. Length, 2·0-2·2 mm.

Queensland: Cedar Creek (Dr. E. Mjöberg), Kuranda, in November (G. E. Bryant). Type, in Stockholm Museum; cotypes in British and South Australian Museums.

A minute, thin, subcylindrical species; the six specimens taken appear to be all males. It is about the size of *A. parva,* and with scales of the same colours, but differently disposed, and with much shorter setae; on *parva* the setae are numerous, and on the elytra the length is decidedly more than the width of an interstice, on the present species the setae are less erect, and indistinct (except from the sides), with the length decidedly less than the width of an interstice; the mesosternal receptacle is also different, on this species its emargination is widely transverse, on *parva* it is distinctly longer than wide. On the upper surface the brown scales may appear as numerous small spots, occupying less than one-fourth of the surface, to half or even three-fourths of it; on the under surface the scales are almost uniformly pale.

Isax tricostirostris, n. sp.

♂. Black, antennae and claw joints obscurely reddish. Densely clothed with dark brown scales, slightly variegated with paler brown ones.

Rostrum thin, feebly curved, the length of prothorax; basal half with crowded punctures, and three thin ridges, apical half shining. Scape inserted slightly nearer apex than base of rostrum, and not quite extending to eye. Prothorax about one-fourth wider than long, apex about half the width of base; with dense and rather small punctures (scarcely larger than on head), and with a fine median ridge, extending to apex but not to base. Elytra somewhat flattened, distinctly wider than prothorax, sides gently rounded to near apex; with rows of fairly large, subquadrate punctures; interstices with rather dense punctures and minute granules, third, fifth, and seventh slightly elevated. Mesosternal receptacle U-shaped, no longer than wide. Metasternum about the length of second segment of abdomen, and distinctly shorter than first, the latter widely concave in middle. Femora stout, feebly grooved and edentate. Length, 8 mm.

New South Wales: Illawarra. Type (unique), in Macleay Museum.

The mesosternal receptacle not twice as long as wide, metasternum shorter than the following segment, and femora edentate are at variance with other species of the genus; the rostrum, although not quite straight, is but little more curved than on *I. planipennis,* and in general appearance it is close to that species. For the present it may be considered an aberrant member of the genus. The type is slightly abraded.

Sympiezoscelus foveiventris, n. sp.

Blackish-brown or reddish-brown, scape paler. With some whitish scales at base of rostrum, and sparse setae on legs.

Head with rather small but sharply defined punctures. Rostrum stout, about two-thirds the length of prothorax, sides incurved to middle; with rather coarse punctures about base, minute elsewhere. Scape stout, inserted about two-fifths from base of rostrum, and much shorter than funicle. Prothorax slightly transverse, sides rounded, and almost evenly decreasing in width to apex; with small but sharply defined punctures, becoming larger on sides. Elytra with outlines continuous with those of prothorax, base strongly trisinuate; with rows of fairly large and somewhat rugose punctures, the marginal and submarginal rows united at about one-third from base; interstices impunctate. Metasternum

depressed in middle, and bifoveate at base. Basal segment of abdomen with two large, subbasal foveae, suture with second with a row of punctures, apical segment irregularly bifoveate. Femora very stout, edentate, tibiae rather short, each with an acute tooth at outer apex. Length, 4·5-6·0 mm.

Queensland: National Park, in December, and Mount Nebo, in April (H. Hacker); New South Wales; Rivertree, in August (E. Sutton). Type, in South Australian Museum; cotypes in Queensland Museum.

A flattened, elongate-elliptic species, readily distinguished from *S. spencei* and *norfolcensis* by the foveae of the under surface, and the much smaller punctures of the upper surface. At first glance the specimens look like abraded ones of *Xestocis*, but on that genus the femora are strongly dentate. There are six specimens under examination, but no well defined sexual differences between them, although on a small one an oedeagus is protruding. Some specimens have the head entirely glabrous.

XESTOCIS NIGER Lea.

Two specimens from Dorrigo (New South Wales), have the elytra of a rather dingy red, with a large black spot on each side of the middle; on the type such spots are present, but scarcely traceable, on account of the darkness of the adjacent parts. On some specimens of *X. castaneus*, from Norfolk Island, there are somewhat similar spots, but on that species the elytral punctures are considerably smaller at the base.

Gymnocis, n. gen.

Head small. Eyes rather small, with coarse facets. Rostrum moderately wide, gently curved. Scape stout, much shorter than funicle; first joint of the latter rather long, second much shorter, the others strongly transverse; club briefly ovate. Prothorax slightly transverse, apex much narrower than base. Scutellum small. Elytra with outlines continuous with those of prothorax, non-striate. Mesosternal receptacle large, with a long central ridge, emargination very short; cavernous. Metasternum much longer than the following segment, largely excavated in middle, sides almost vertical; episterna rather narrow. Two basal segments of abdomen large and soldered together, third and fourth combined distinctly shorter than fifth, with deep sutures. Femora very stout, feebly grooved, edentate; tibiae compressed, with a small subapical tooth, in addition to terminal hook, the middle and hind ones each with a feeble projection near outer apex; tarsi thin. Elongate-elliptic, depressed, glabrous.

A remarkable genus, allied to *Bepharus* and *Sympiezoscelus*, but distinguished by the cavernous metasternum, and complete absence of elytral striae. The outlines are much as those of *S. foveiventris*, and the femora are similarly powerful. The cavity of the metasternum is continued as a wide, shallow depression, on the two basal segments of abdomen, and the latter are soldered together, even at the sides, their suture only marked by a curved row of minute punctures.

Gymnocis impunctatus, n. sp.

Blackish-brown, antennae and tarsi somewhat paler. Elytra with muddy-grey scales, and a few setae, only about apex, on front of head, base of rostrum, sides and tip of abdomen, and parts of legs; metasternum with a few setae between coxae, and a few on claw-joints.

Head polished and impunctate, except in front, where the punctures are concealed. Rostrum shining and impunctate, except at base. Scape inserted slightly nearer base than apex of rostrum. Prothorax with sides rounded, base narrowly margined; impunctate. Elytra with sides feebly dilated to basal third, and then narrowed to apex; without punctures, except a few concealed ones about apex. Length, 4·5 mm.

Queensland: National Park, under bark of a rotten hoop-pine *Araucaria Cunninghamii* in December (H. Hacker). Type (unique), in Queensland Museum.

At first glance apparently entirely glabrous and without punctures; the few that are present being more or less concealed by muddy-looking scales.

Idiopterocis, n. gen.

Head small, almost concealed from above. Eyes small, widely separated, with coarse facets. Rostrum moderately long, rather wide, moderately curved. Scape moderately stout, much shorter than funicle; first joint of funicle long, second shorter, the others small and transverse; club briefly ovate. Prothorax rather long, flat, sides almost vertical. Elytra nonstriate, with vertical sides. Mesosternal receptacle rather large, emargination widely transverse; cavernous. Metasternum distinctly shorter than the following segment; episterna narrow. Femora moderately long, feebly grooved, edentate; tibiae slightly compressed; tarsi thin. Elongate, flattened, irregularly squamose and setose.

A remarkable genus, evidently allied to *Bepharus, Sympiezoscelus,* and *Gymnocis,* but distinct by the elytra, metasternum and abdomen. In the table of allies of *Chaetectetorus,* it could be associated with *Metyrculus,* but the two genera differ in many particulars (prothorax, elytra, eyes, etc.). The elytral epipleurae, to a certain extent, are suggestive of those of *Zenoporopterus mirus.* The tarsi are thin, and the third joint, although bilobed, is not widely so. There is a minute process at the position of the scutellum, but I am not sure whether it is a real one, or a minute scaly depression; it is certainly not a distinct scutellum.

Idiopterocis trilinealbus, n. sp.

♂. Black, some parts shining, antennae and tarsi reddish. Irregularly clothed with white, or stramineous, scales and setae.

Head with dense, concealed punctures. Rostrum about the length of prothorax, with a fine median carina, and dense concealed punctures, except that the tip is glabrous, and with small punctures. Antennae inserted almost in middle of rostrum. Prothorax slightly longer than wide, sides feebly dilated from base to one-third from apex, and then narrowed to apex, which is more than half the width of base, base truncate; disc with fairly large, even punctures, becoming smaller on sides. Elytra closely applied to prothorax, with shoulders feebly clasping its base, sides slightly dilated to basal third, and then regularly narrowed to apex; parts polished and with sparse and minute punctures, except where clothed, both on disc and epipleurae. Two basal segments of abdomen widely and shallowly depressed, the first distinctly longer than second, second slightly longer than third and fourth combined, with straight sutures. Length, 3·3-3·5 mm.

♀. Differs in having rostrum slightly thinner, median carina shorter, about one-fourth of its apex glabrous, abdomen flat, and femora slightly thinner.

Lord Howe Island (A. M. Lea and wife). A pair taken, *in cop.,* on the under surface of a rotting log.

The prothorax is rather densely clothed with scales, each of which fills a puncture, but there are also a few setae arising above the general surface, on the sides the scales are smaller, and cover less of the surface; on the elytra there are three conspicuous lines of white scales (with a few long and slightly rusty setae), on the suture and crowning the vertical sides, with a few scattered scales, so the disc has two widely glabrous spaces, narrowing to apex, with the epipleurae also almost completely glabrous; the abdomen is glabrous, except on the sides; the femora and tibiae have pale scales and long setae. Most of the derm of the female is reddish, but probably from immaturity.

Mitrastethus lateralis, n. sp.

♂. Castaneous-brown. Densely clothed with light, muddy-brown, adpressed scales, slightly mottled with darker brown, but highly polished on outer side piece of mesosternum, on prosternum adjacent to it, on middle of metasternum, of two basal segments of abdomen, and hind coxae; each odd interstice of elytra with a row of short, sloping setae.

Rostrum feebly curved, the length of prothorax; apical fourth polished and almost impunctate. Scape stout, inserted slightly nearer base than apex of rostrum, and much shorter than funicle. Prothorax moderately transverse, apex less than half the width of base, which is strongly bisinuate and with a small median depression; with dense, concealed punctures. Elytra not much wider than prothorax, nowhere quite parallel-sided; with rows of rather large punctures, appearing much smaller through clothing; interstices with dense, concealed punctures. Femora stout, edentate, hind tibiae thicker than the others. Length, 5-6 mm.

♀. Differs in having rostrum longer, thinner, clothed only on basal third, and basal segments of abdomen gently convex in middle, instead of flattened.

Norfolk Island (A. M. Lea). Abundant.

A rather flat, elliptic species, with general appearance much as of the two previously named species, but each outer side piece of mesosternum, etc., highly polished and glabrous, in all the numerous specimens obtained. On some males of *M. australiae* the outer side piece is polished, although it usually has a few scales; but on the female it is usually as densely clothed as the adjacent parts; some Dorrigo specimens are quite as small as those of the present species, but the majority are considerably larger.

MITRASTETHUS AUSTRALIAE Lea.

Four specimens from Queensland, in the National Museum, have fairly numerous black setae scattered amongst the pale ones on the elytra. Numerous others from Dorrigo (New South Wales), are smaller than usual, and also have a few black setae scattered about, but less numerous than on the four others.

ATMOSPHERIC SATURATION DEFICIT IN AUSTRALIA.

By JAMES ARTHUR PRESCOTT, M.Sc., Waite Agricultural Research Institute.

[Read August 13, 1931.]

The importance of the saturation deficit of the atmosphere in water vapour pressure has received attention of recent years, particularly from workers in plant physiology and in soil science. The effectiveness of rainfall for plant life or in the process of soil leaching is governed by the evaporating power of the air, and it has been shown by Patton (1) and by the author (2) that for Australian

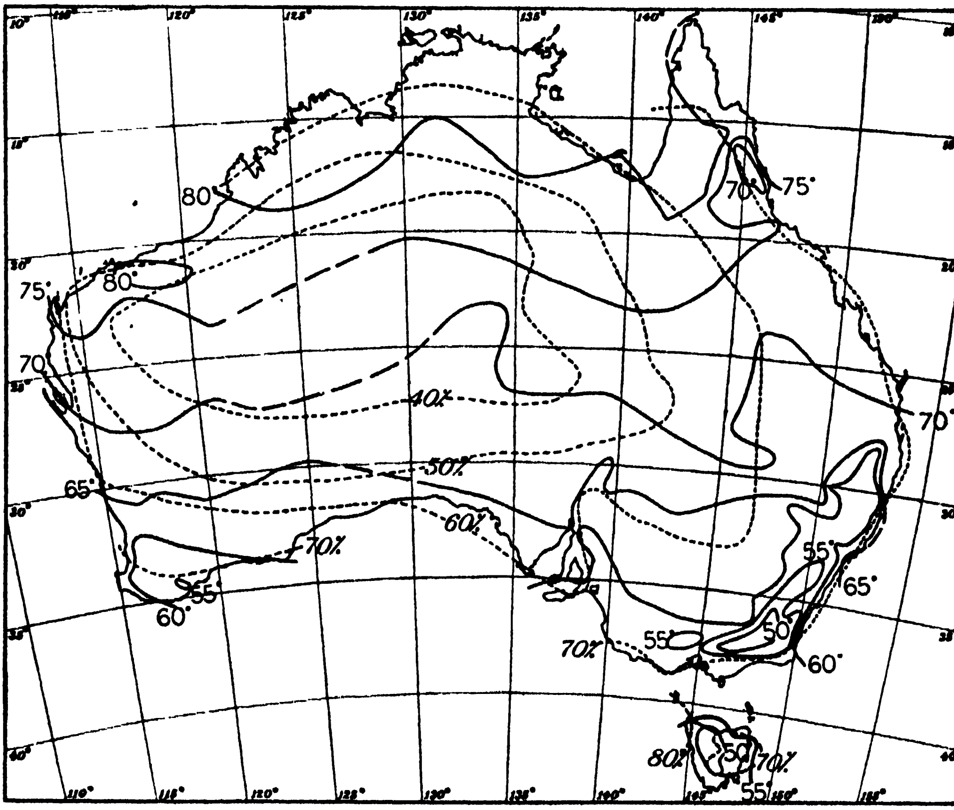

Fig. 1.

Map of Australia, showing mean annual temperatures and mean annual humidity based partly on data supplied by H. A. Hunt, 1929. Isotherms are indicated by continuous lines, humidity percentages by broken lines.

records the evaporation from a free water surface is probably a linear function of the saturation deficit of the air.

For twenty-three stations in Australia the mean evaporation in inches is related to the saturation deficit in inches of mercury by the following expression:—

$$E = 263 \text{ s.d.}$$

Of the factors which have been discussed in this connection, the most important are:—The Transeau ratio (3) of precipitation to evaporation, and the Meyer ratio (4) of precipitation to saturation deficit. Factors taking account of

rainfall and temperature include those of Lang (5), de Martonne (6), Emberger (7), and Crowther (8). It is very probable that in these latter cases for working over a wide range of temperature and humidity conditions, the saturation deficit will eventually prove to be more useful than temperature.

During the course of recent investigations on the distribution of soil types and vegetation associations in Australia, the probable values for the saturation deficit have been worked out from the most recent available temperature and humidity records, and these are submitted in the following maps. Fig. 1 indicates the data from which the saturation deficit isobars in fig. 2 have been calculated.

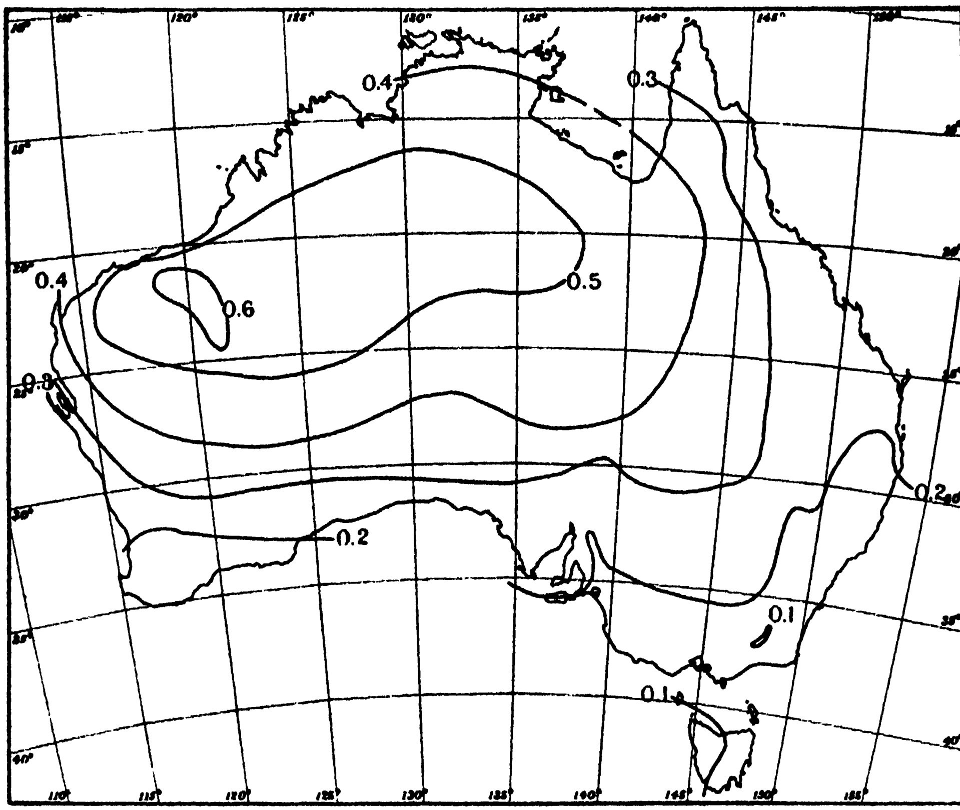

Fig. 2.

Map of Australia, showing isobars of vapour pressure saturation deficit expressed in inches of mercury. This deficit is roughly proportional to the evaporation from a free water surface, the general relationship being expressed by the equation $E = 263$ s.d. The values for the saturation deficit are based on the data of Fig. 1.

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ON MAMMALS FROM THE DAWSON VALLEY, QUEENSLAND. PART I.

By H. H. Finlayson,
Hon. Curator of Mammals, South Australian Museum.

[Read September 10, 1931.]

Plates I. to III.

The earlier practice of Australian Museum staffs, in publishing accounts of collecting expeditions and of giving lists of mammals met with in various districts, seems largely to have been abandoned in recent years. As compared with the great volume of detailed information relating to the occurrence of birds, for example, published by the different Ornithological bodies, the data for mammals is sparse and infrequent, and, curiously enough, all the more important contributions on this head have been made by Europeans not resident in the country.

Australian workers seem to have been more and more content to confine their published records to occasional specimens of interest which have been submitted to them for identification, and, with a few early exceptions, regional surveys of the type which have made West European and North American mammalogy almost an exact science, are not undertaken.

This state of affairs is most unsatisfactory. It not only hampers a much needed campaign of museum collecting, intelligently co-ordinated, but the lack of local records has an embarrasing effect on the discussion of some theoretical problems, as pointed out recently by H. A. Longman and partly remedied by him. ("Mem. Queensland Mus.," vol. x., pt. 1.) On theoretical grounds, indeed, the need for a full and accurate statement of the constitution and distribution of the mammal fauna is obvious, and the frequent revision of this data is urgently required in determining the rational incidence and duration of protective legislation. As is absurdly apparent in some of the official lists which have appeared from time to time, the records of thirty, or even ten years ago, are not a reliable basis for determinations of the present status of species.

In the summer of 1928-29 the writer spent three months in the Dawson Valley, Central Coastal Queensland, for the purpose of observing and collecting mammals. The district was chosen, partly because it supports an unusually dense and varied Macropod fauna, in which group interest was chiefly centred; partly because far-reaching schemes of closer settlement are mooted there, which, if carried through, will render such a survey increasingly difficult and incomplete.

Collecting and investigation were carried out at numerous points along the Dawson and Fitzroy Rivers, from Taroom in the south to Mount Hedlow in the north. The region is a highly diversified one as to physical features, but as practically the whole of the country worked over has been excellently described and illustrated in two brochures issued by the Lands Department and Irrigation Commission, Brisbane, it will be unnecessary to give further description here.

Over the greater part of the area the Macropod element in the fauna is overwhelmingly dominant, and it is only in the more humid coastal zone to the north and east that the *Dasyuridae, Peramelidae,* and smaller *Phalangeridae* become numerous. This, together with the limited time available and the special interest cited, are responsible for the fuller treatment accorded the former, but, nevertheless, no opportunities were lost of obtaining both specimens and records of all, and the notes given provide a fair estimate of the present state of the fauna. The

material obtained by the writer in person has been usefully supplemented in many cases by specimens taken during the succeeding winter by friends resident in the area.

The most extensive collecting previously done in this part of Queensland is that of Lumholtz, who spent much time from 1880-1884 in the Rockhampton District in the northern portion of the area here dealt with, and whose collection was worked out by R. Collett in "Zoologische Jahrbücher," Band II., 1886-1887, p. 830, *et. seq.* Collett's work is a most comprehensive one on the systematic and osteological side, but is necessarily deficient in the all-important data which calls for personal observation in the field. In the present paper opportunity has been taken, not only of dealing briefly with habits (chiefly as they affect distribution), but of giving detailed flesh measurements and other observations from living or recently killed animals.

The comparative utility of these measurements and the methods of determining them will be dealt with more fully elsewhere; for the present they are sufficiently defined in "Trans. Roy. Soc. S. Austr.," liv. (1930), p. 55.

MACROPUS GIGANTEUS TYPICUS(1) (Forester).

Widely distributed up and down the valley in suitable country, but never, in my experience, as plentiful nor forming such large groups as it does in New South Wales and Victoria. Near the towns and closer settlement areas, and in the sheep country, it is, of course, one of the first species to disappear, but in the great stretches of cattle country it is regarded very tolerantly, and is not being seriously pressed to maintain its position.

Few Australian animals have been so appropriately named in popular usage. From Tasmania north, over the whole of its range, it exhibits the same preference for open park-like forests where the floor is grassy and free from undergrowth, and the same shunning both of open plains and dense scrubs. In the Dawson Valley its typical habitat might be said to be the river flats of Moreton Bay Ash and Coolibah, but in several localities it is well represented in hilly country. This is notably so on the Grevillea Plateau, where it is rapidly becoming more plentiful as the adjacent lowlands are split up for closer settlement. These plateaus present rougher country than the flats, but they are yet quite openly timbered and well grassed, though with somewhat coarser species. Specimens were obtained at Box Tree Creek in the Taroom district, at Drumburle on the Grevillea Plateau, and at Coomooboolaroo, south of Duaringa, and they may be completely merged as Collett found, with representative series of skins from New South Wales and Victorian localities. There is some variation in coat colour, and the summer coat is short and harsh, but not more so than frequently obtains in the south. Winter skins have not been examined.

Flesh dimension of an aged male from Coomooboolaroo and a subadult female from Drumburle are as follows:—Head and body, 1,110, 835; tail, 1,165, 800; chest (girth), 660, 365; manus, 105, 80; nail of third finger, 38, 23; pes, 380, 320; fourth toe, 140, 125; nail of fourth toe, 50, 36; ear, 138 × 67, 125 × 68; rhinarium to eye, 116, 90; eye to ear, 80, 73; weight, 114½ lbs., 50 lbs.; humerus, 202, 110; ulnaradial, 235, 197; femur, 282, 220; tibia, 537, 380.

Skull dimensions of the above male are:—Greatest length, 195; basal length, 183; zygomatic breadth, 100; nasals, length, 85; nasals, greatest breadth, 24; depth of muzzle, 37; constriction, 24; palate length, 128; palate, breadth inside M^2, 33; anterior palatine foramen, 9; diastema, 60; basi-cranial axis, 49 (ca); basi-facial axis, 130 (ca); facial index, 265 (ca); $M^{1\text{-}3}$, 32·5.

(1) In indicating dominant varieties this usage is preferred, throughout the paper, to the repetition of the specific name.

Macropus giganteus melanops.

This well-marked variety of *M. giganteus* is the common kangaroo of the mallee belts of the south-eastern portion of the continent, and has recently been recorded for Queensland by Longman, though without detail as to locality *(loc. cit.)*. It was not observed in the area under consideration, nor could any evidence of its presence be obtained by enquiry amongst residents of long standing. As its external appearance is very different from that of the Wallaroo and Forester, its absence from the district may be safely assumed. It may be noted also that no scrubs of similar texture to the mallee are to be found along the Dawson.

Macropus robustus typicus (Wallaroo).

Numerically, the Wallaroo is the chief kangaroo of the district, and has a wide but sporadic distribution there. It is everywhere well known, and frequently plentiful, more particularly in the south.

Although it shows a preference for rough and rocky country, it is much less of a hill kangaroo than any of the more westerly sub-species I am acquainted with, and many of the higher weathered ranges with exposed outcrops and little timber (an environment which would be considered typical "euro" country in South and Central Australia) are quite deserted by it. This may be due, in part, to the flanking of these hills with more or less dense brigalow and softwood scrubs, which would tend to cut it off from the lower feeding grounds, but it remains true, I think, that its adaptations to a mountaineering life are somewhat inferior to those of the inland forms. In the country drained by the Downfall, Cockatoo, and Palm Tree Creeks, on either side of the Dawson, at the Nathan Gorge, wallaroos are very plentiful, and are here found on the little plateaus between the precipitous creek gorges—these tops are here quite thickly timbered often with *Callitris* thickets, and a love of such cover seems to be highly characteristic of the wallaroo. Further north, along the lower reaches of the Dawson, at Coomooboolaroo for instance, the country is much less rough and broken than in the upper districts, and the little ironstone ridges, densely grown with the lance-like rosewood, in which it is chiefly found, form a most unexpected habitat for any member of the *robustus* group. In fact, its habitat here in the north is scarcely differentiated from that of *giganteus*, for, though it camps amongst the rocks on the ridges during the day, its feeding grounds are practically identical or at least largely overlap those of the Forester.

It is rather solitary, and seldom more than two were put up together. Old males were always alone. Sexual differences as regards size, colouration, and general aspect are very marked. The full-grown male is in every way a most remarkable kangaroo, and in external features totally different from any other species. When seen at some distance, it appears quite black; the arms and shoulders are very heavy and powerful; it carries itself with an habitual stoop, and even when startled at close quarters never seemed to me to assume an altogether upright position. Its movements are slow and rather ponderous, and the coarse, shaggy coat and long pendant hairs of the sides of the face combine to convey a curious impression of uncouthness.

Old males are exceedingly tenacious of life, and will struggle away over rocks and frequently escape with wounds which would completely incapacitate *rufus* or *giganteus*. I noticed here, with the variety *typicus*, as I have often done with *erubescens* in South Australia, that the coat of the male when freshly killed is quite sticky, and on the ventral surface the skin and the base of the hairs have a distinct greasy deposit, not unlike the suint elaborated by sheep. The peculiar red pigment, so well known on *rufus* and recorded for this species by Le Souef "Aust. Zoologist," vol. v., p. 249 (1928), was not noted. (See, however, page 72.)

Unfortunately, no adult females were measured, but there can be no doubt that the does, even at full growth, are much smaller than bucks, and are quite differently built. Although without the heavy fore-quarters of the bucks, there is yet a suggestion of "dumpiness" about them, and they lack much of the trimness of *giganteus* and *rufus* does.

In referring the Dawson Valley wallaroo to *M. robustus typicus* some qualification is necessary, as a comparison of the skins obtained with others from the New England district of New South Wales brings out considerable differences in colouration, particularly in the males. These differences may be partly seasonal in character, as winter skins from Queensland have not been available (cf. Le Souef, *loc. cit.)*.

In the northern skins the dorsal surface of males is strongly suffused with red-brown, the bases of the hairs being of this colour, and their tips pure black. In the New South Wales specimens the general tone is a much colder slaty black, the hairs basally not being strongly contrasted with the tips, and a distinct bluish tinge being apparent on parting the fur. Collett *(loc. cit.)* noted that in specimens from Coomooboolaroo the tail was black, and this is a striking peculiarity of all the Dawson wallaroos. The whole of the tail, both above and below, from base to tip, is jet black, whereas in the New South Wales animal it is lighter below than above, and is nowhere quite black except at the extreme tip. The limbs are similar, but areas which are cream or honey-coloured in the southern animal are red-brown in the northern.

The female is closer to the typical form than the male, but is likewise distinguished by a pinkish suffusion approaching that of *erubescens.* Both sexes in the north have a harsher coat, and all hair tracks and opposition ridges are more marked, particularly about the face.

The skulls[2] agree closely with those from New England.

The external differences mentioned are probably as considerable as those which separate some of the so-called sub-species of *robustus,* but having noted the variations from the type and the locality in which they occur, there seems little to be gained by adding further to the list. The lavish application of names to the colour phases of variable species is of doubtful value at any time, and when it is done, as it very often has been done with marsupials, without the least knowledge of the animal in nature, it can scarcely command serious attention.

Flesh dimensions of an adult male (P^4M^4) from Coomooboolaroo:—Head and body, 985; tail, 1,000; girth of chest, 550; manus, 83; nail of third finger, 27; pes, 317; fourth toe, 115; nail of fourth toe, 35; ear, 125 × 65; rhinarium to eye, 100; eye to ear, 75; humerus, 155; ulnaradial, 240; femur, 265; tibia, 415.

The skull of this male has:—Greatest length, 180; basal length, 164; zygomatic breadth, 93; nasals, length, 74; nasals, greatest breadth, 29; nasals, overhang, 14; depth of muzzle, 36; constriction, 17; palate, length, 109; palate, breadth inside M^2, 29·5; anterior palatine foramina, 10; diastema, 40; basi-cranial axis, 48; basi-facial axis, 123·5; facial index, 256; molars $^{1-3}$, 30·5; P^4, 8·5.

Teeth in a young skull:—I^1, 5 × 10·5[3]; I^2, 4·5 × 6·5; I^3, 9·5 × 6·5; P^3, 7.

(2) On extending the comparison to *erubescens,* of which a large series of skulls has been available, I find that the anterior palate: diastema ratio, determined by Schwarz, holds good. In addition, the unworn molars of *erubescens* are slightly larger than those of *typicus,* and its muzzle region, even in very aged skulls, does not undergo that lateral bulging which in *typicus* approaches the normal condition seen in *antilopinus* (see Wood-Jones, "Mammals of S.A.," vol. ii., p. 251). I cannot agree with Mr. Le Souef, however *(loc. cit.),* that these and some differences in colouration are of sufficient importance to warrant the separation of *erubescens* as a full species.

(3) Values for incisors are antero-posterior length × vertical height (of enamel).

Subgenus *Wallabia*.

From the point of view of the occurrence and distribution of the "Large Wallabies," the Dawson Valley is of great interest, as of the six existing mainland species, five are to be found within its confines, the single absentee being the isolated West Australian, *M. irma*.

This is true of no other district in Australia, and as the habitat zones of the different species, though for the most part well defined and discrete, constantly recur in close proximity to one another over the whole area, unique opportunities for the study of contrasting habits and general bionomics, are presented. These matters, however, can be touched on but very briefly here.

It may be noted that two species, *M. ruficollis* and *M. agilis*, find, respectively, the northern and southern limit of their range here.

MACROPUS (W.) AGILIS (Bunga).

This wallaby has long been known to occur on Stradbroke Island, off the mouth of the Brisbane River, and is the commonest large wallaby in North Queensland, but the extent of its range southward along the coast has been a matter of uncertainty. The most southerly occurrence definitely recorded appears to be that at Inkerman, in the Burdekin River district. [O. Thomas. P.Z.G. (1908), p. 703.] It was with some surprise, therefore, that the species was found to be fairly numerous and quite well known along the valley of the Fitzroy,[4] and within a few miles of Rockhampton, 320 miles further south.

It occurs sparsely on the lower grassy slopes of the Berserker Hills, but is more numerous in the long-grass flats which border the creeks, feeding the Fitzroy from the north, and, in particular, it was observed and specimens obtained on the Serpentine and Mount Hedlow Creeks. This is a country of more or less coastal characteristics, *i.e.*, both humidity and rainfall are higher than inland, and vegetation notably more luxuriant, and it is probable that it is confined to this coastal belt and does not penetrate inland to any extent. Whether it is to be found, at present, further down the coast I am not able to say from personal observation. If the "River" or "Grass" wallaby is actually *agilis*, however, then it certainly extended much further south as late as 30 years ago, as I had frequent accounts of it from men who knew the coast at that time. Mr. H. A. Longman, Director of the Queensland Museum, informs me that he has seen captive examples at Gladston; their place of origin, however, was not ascertained and was probably not local, as Mr. R. Vallis, a keen observer of the local fauna, who knows both the Rockhampton and Gladston districts well, assures me that he has never seen it at the latter place.

It does not occur along the Dawson proper. This southern representative of the species, in its short summer coat, is a very handsome wallaby, the ground colour of the dorsal and lateral surfaces being a rich, almost orange, buff, with but little pencilling of darker tips to dull the colour effect. The cheek stripe and hip stripe are strongly marked, the nape is more rufous than the back, and except that the toes show little darkening distally, both male and female agree well with *M. agilis jardinei*, as given by Schwarz.[5] [Ann. Mag. Nat. Hist., series 8, vol. v.,

(4) Not to be confused with a river of the same name in North-West Australia, from which *agilis* has been recorded and discussed by Lonnberg.

(5) The forms described by Schwarz are undoubtedly recognisable as colour phases, but whether they are valid in a geographic sense may be doubted. In going over considerable series of skins from the Kimberleys, Arnhem Land, Groot Eyelandt and the Queensland peninsula in my own collection, and in the S.A. Museum, examples agreeing more or less with *aurescens*, *agilis*, and *jardinei* are to be found from each place.

(1910), p. 164.] Winter skins subsequently obtained from the same locality, however, show a considerable increase in the grizzling of black and white hair tips, and this imparts a much greyer and colder tone to the coat. Both the male and female, taken in March, were strongly suffused over the whole ventral surface with a rich crimson waxy exudate, showing up conspicuously on the throat, chest, base of tail and inguinal areas. As already mentioned, this is a familiar feature in *M. rufus.* A. S. Le Souef has recorded it for *M. robustus, Petrogale rothschildi,* and *P. purpureicollis,* and I have observed it on old males of *giganteus typicus* (in February, Ryan's Creek, North-east Victoria), but I have not seen it previously on a brush wallaby, nor on a female of any other species. Certainly in *rufus,* and probably in all species, it is a seasonal feature and connected with heightened sexual activity, but the times of its incidence and maximum development have yet to be determined.

Dimensions of a subadult male (P^3M^3) and female (P^4M^3), shot together on the Serpentine Creek, are as follows:—Head and body, 725, 643; tail, 860, 770; chest, 390, 340; manus, 70, 52; nail of third finger, 29, 26; pes, 258, 233; fourth toe, 95, 85; nail of fourth toe, 29, 33; Ear, 91 $\times$48; 81 $\times$ 40; rhinarium to eye, 82, 80; eye to ear, 58, 55; weight, 39, 27 lbs.; femur, 202, 185; tibia, 288, 270; ulnaradial, 155, 134; humerus, 112, 95.

Skull measurements of a subadult male (P^4M^3), and an adult female from the Serpentine, follow:—Greatest length, 145, 139; basal length, 133·5, 126·5; zygomatic breadth, 77, 78; nasals, length, 64, 60; nasals, greatest breadth, 22·5, 23; nasals, overhang, 12, 11; depth of muzzle, 26·5, 24; constriction, 17·5, 16; palate, length, 91, 85·5; palate, breadth inside M^2, 26, 26·5; anterior palatine foramina, 8·5, 9; diastema, 37·5, 33; basi-cranial axis, 39, 36; basi-facial axis, 100, 94; facial index, 256, 261; molars $^{1-3}$, 27, 23; P^4, 9·5, 8·5.

Incisors in a young skull have I^1, 5 $\times$ 11; I^2, 4 $\times$ 5; I^3, 7·5 $\times$ 5·5.

MACROPUS (W.) DORSALIS. ("Wallaby"; "Scrubber.")

Probably the most numerous and widespread mammal in the district, and, indeed in coastal Queensland generally, and usually referred to simply as the "Wallaby."[6]

Year in, year out, since the opening up of the country, it has been systematically snared and shot, but, in spite of the enormous destruction thus caused, its numbers are apparently little, if at all, diminished. Residents of long standing have pointed out to me quite small patches of scrub which have been closely snared every winter for 40 years, and in which the species is as plentiful as ever. Much the same may be said of *M. billardieri,* in Tasmania, and *M. eugenii,* on Kangaroo Island, South Australia, and it would seem as though the yearly "pruning" of these wallaby colonies, within limits, actually stimulates the rate of increase, possibly by removing aged males, which always form a large proportion of the catch at the beginning of operations.

In the Dawson Valley, and, I believe, over the greater part of its Queensland habitat, *dorsalis* has become sedentary and gregarious to a degree quite unapproached by any other large wallaby. A. S. Le Souef (Wild Animals of Australasia, p. 189) speaks of it being found in "South-Eastern Australia," in "rough, open country"; but in the area treated here it is absolutely confined to scrubs and jungles, and its mode of life is not definably different from that of the *Thylogale,* to which group, in fact, it seems allied by several structural features as well.

Over the greater part of the valley its typical stations are the great stretches of Brigalow scrub, which make up a large proportion of the total area. The pure

(6) Further north this usage is transferred to *M. agilis,* according to Lumholtz.

Brigalow country, although containing dense stands of trees, has a fairly open floor, but more common are the Brigalow-softwood communities, in which growth is much denser through the development of a bushy undergrowth and interlacing vines. When this type of scrub is invaded by the prickly pear it is converted into practically impenetrable jungle, in which, however, the "wallaby" is still at home. In the wetter country towards the coast, on the Fitzroy, the Lantana thickets form its chief stronghold.

In habits it is shy and secretive, not given to daylight feeding, and, therefore, difficult to observe. Even in scrubs where it is numerous it is difficult to obtain more than fleeting glimpses of it as it retreats ahead of one down its runaways. It clings very closely to its cover, and I suspect that most of its feeding is done within the scrubs and that it does not rely to any great extent on the grass of the open country (in summer, at least). Although rarely seen in the open except in flood times, it has a well-marked trait in that it dislikes the dripping scrubs after rains, and at such times it will come out in numbers along the edges of the Bauhinia flats which frequently skirt the scrub in the lower country.

On inspection of the animal in the flesh, a number of minor external characters are to be noticed which may be added to existing descriptions. Attention has not been drawn, I believe, to the relatively very large size of the fore-limb—a most conspicuous feature in the general make-up of the animal. Not only is the whole limb very long, but the proximal segment is powerfully muscled and maintains its width almost evenly from shoulder to elbow. The arm is carried very straight at the side, with the two segments nearly in line.

The foot is small and slender. Three fully adult males give a mean value for its length of 205 mm., the lowest figure I have obtained (in flesh measurements) within the subgenus. The nail of the fourth toe is uniformly long, sharp-pointed, and unusually straight, the dorsal edge having practically no curvature.

Many examples of both sexes and differing ages were found to have failed in the development of the normal pigmentation of the soles of the feet, palms of hands, and rhinarium, these parts appearing either entirely flesh-coloured or irregularly mottled. The tail is more sparsely haired than in any other brush wallaby, and throughout the greater part of its length (in summer skins) the epidermal scales show through plainly. Gould's statement ("Mammals of Australia"), based on examples from The Namoi in New South Wales, that "it is distinguished from all other species by the greater length of the tail" is not applicable to the Dawson Valley animal. The ratio of, length of head and body : tail, in adult males[7] is there, as 1 : 1-14, a value which is exceeded by *irma* 1·36 +, by *parryi* 1·34, and by *ruficollis* 1·27.

The internal surface of the ear is bluish. On examining several hundred skins of *dorsalis* it is apparent that the general colour of the pelage and the development of the cheek, dorsal and hip stripes, are all subject to considerable individual variation. Comparison of a selection of these Dawson skins with others from South Queensland, indicates the existence of similar differences in these localities, which cannot be correlated in any definite way with either age or sex.

The seasonal change is marked. The coat becomes much denser and longer in the winter, and there is a marked intensification of the colour on the rufous areas of the fore-quarters and rump.

In all old males examined, the disposition of the hair tracts on the nape and shoulders is quite different from any other "Large Wallaby." The normal caudad tract takes rise, as usual, at a point near the occiput, but is greatly restricted in extent anteriorly by two areas of reversal which radiate from a point near the

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(7) The relative length of the tail is less in females of all species of *Wallabia* examined.

armpit and cover the greater part of the scapular and nuchal surfaces with hairs directed cephalad. In a dorsal view the effect is very striking, since two converging opposition ridges are produced which, meeting the black dorsal stripe, form a sharply-defined arrowhead. (See fig. 1.)

In regard to its adult[8] dimensions and skull characters, *dorsalis* is remarkably variable, and this may perhaps be explained in terms of its varying adaptation or readaptation to a gregarious, sedentary life.

Detailed measurements of an aged male (P^4M^4) from relatively open Brigalow country on Spring Creek, in the Upper Dawson Valley, and the four conventional measurements of an adult female (P^4M^4) from a Lantana scrub, on the Fitzroy, are as follows:—Head and body, 720, 550; tail, 825, 580; girth of chest, 385; manus, 64; nail of third finger, 27; pes, 205, 157; fourth toe, 75; nail of fourth toe, 30; ear, 88 × 46, 83; rhinarium to eye, 78; eye to ear, 55; weight, 35 lbs.; femur, 180; tibia, 260; humerus, 136; ulnaradial, 175.

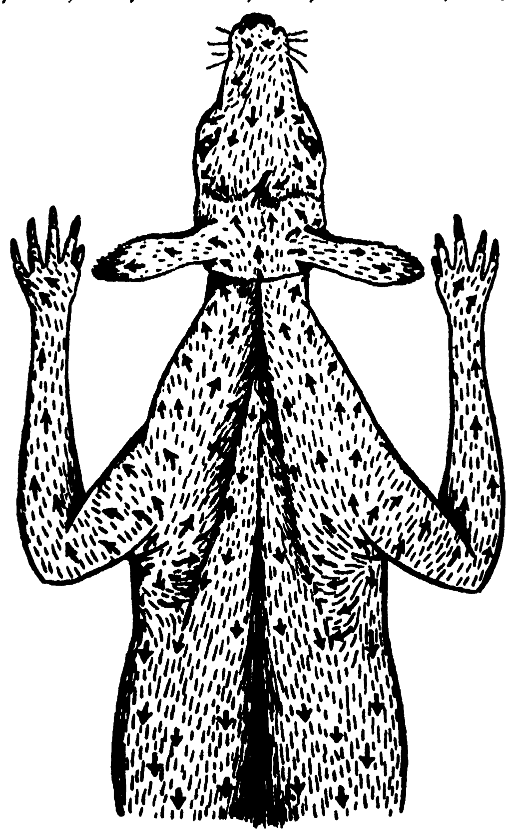

Fig. 1.
Dorsal surface of *M. (Wallabia) dorsalis,* showing the hair tracts. An aged male.

In the adult skull there is not only a great range of variation in size, in the shape of the nasals, the condition of the interorbital region, and of the temporal ridges, but there are frequent anomalies in tooth succession and some degree of asymmetry about the muzzle region is common.

(8) Throughout this paper the term "adult" is used as by Schwarz, for animals in which both P^4 and M^4 are in position, and not as by Thomas in the catalogue of 1888.

The mean values for skull dimensions of three males and two females (all P^4M^4) are as follows:—Greatest length, 135, 119·5; basal length, 121·5, 106·5; zygomatic breadth, 67, 58; nasals, length, 55, 44; nasals, greatest breadth, 21·5, 15; depth of muzzle, 22·5, 19;; constriction, 15, 15; palatal length, 80·5, 72; palate, breadth inside M^2, 23, 20; anterior palatine foramina, 7, 6; diastema, 33, 29·5; basi-cranial axis, 36, 33; basi-facial axis, 89, 76; facial index, 247, 230; M^{1-3}, 22·5, 19·5.

The basal length for adult males may fall as low as 109 mm.

MACROPUS (W.) PARRYI (Whiptail).

This magnificent species still occurs in large numbers in suitable tracts all over the valley, but in the northern part of the area is rapidly diminishing. In 1884 it was obtained by Lumholtz near Rockhampton and on Coomooboolaroo, for instance, but is now quite unknown in the vicinity of the first place and on the second has become rare.[9]

It resembles the Toolache in spending the greater part of its time in very open country, and is more easily approached and observed than any other wallaby in the district. Typical of the whiptail habitats are the beautiful undulating upland parks of the broad-leafed ironbark *(Eucalyptus siderophlora)*—richly grassed and with frequent low, broken, rocky outcrops, bordered sometimes by wattle or Brigalow scrubs, but in themselves quite free from bush growth of any kind and with the trees rather widely spaced. As a characteristic example of this type of country might be cited the Grevillea plateau, where *parryi* is still in very large numbers.

Not only is its feeding done in such surroundings, but it makes its camps amongst the exposed rocky outcrops and is thus always more or less in view. It is rarely or never seen in a scrub. It is, no doubt, this fact of its frequently been seen amongst rocks which inspired the old name, "Parry's Wallaroo," but which a practical knowledge of both species proves to be unjustified, as except for an increase in the bulk of the toe pads, it makes no approach to *robustus* in structure. Its temperament also is quite different, and in no part of the valley was I able to examine whether their habitats overlap.

It is diurnal to a greater extent than any other brush wallaby, and except during the hottest weather may be seen feeding out in the open till 10 a.m. in the mornings and again after 4 p.m. in the afternoons, and in winter, I am informed by those who are constantly riding over its beats, it may be seen about all day. It is distinctly social in habit, and very likely truly gregarious, though it would take closer and more prolonged observation than I was able to give to determine the point. It certainly camps in rather large parties, 12 or 15 being frequently seen lying up together, but in the late afternoon, when feeding begins in earnest, there is a tendency, I believe, for the larger males and females to go off in pairs. At Drumburle, where I watched it most, they were so numerous, however, that towards evening whole hillsides were dotted with the members of these disbanded camps, and it was impossible to make out the existence of any natural grouping. Old males are always solitary, as in many other species.

The midday camps can be approached fairly closely, and are then seen to be most unrestful affairs; there is a constant preening and scuffling and changing of position, with interludes of playful sparring, much in the manner characteristic of *M. rufus*. In January there were no indications of rutting and females were taken with young in many stages, from almost independent "joeys" to naked embryos of 200 mm.

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(9) I am indebted to Mr. H. G. Barnard for the information that there are signs that it is recovering its former position in the Dawson Range on the southern end of Coomooboolaroo.

More than once, evidence was obtained of a degree of attachment between the sexes unusual in marsupials. On one occasion a young male (P^3M^2) and an older female (P^4M^3) were observed feeding alone in a gully. The male was shot, and the female immediately made off in a panic, but stopped at about 150 yards and looked back. Within a few minutes, not having seen me, she returned to the body of the male and, after circling it in a cautious and hesitating way, to my amazement, launched a violent attack upon it, striking repeatedly with her feet, springing back and striking again, with every appearance of rage and desperation. So engrossed in this was she that I was able to approach very close, and then perceived that her blows were solely directed at a great superficial wound on the flank of the male caused by emergence of the high velocity bullet.

It is well known that partially disembowelled animals will tear desperately at the extruded viscera with their teeth. In the case of kangaroos instances of it have frequently been told me by professional shooters, and I have observed it myself. My impression is strongly that in such cases the animal is mistaking the wound, or gut, objects which are entirely strange to it, for something which is altogether extraneous and which is responsible (by aggression) for their distress. In the above case, I have no doubt that it was the intention of the female to assist the male in beating off an attack.

Like so many mammals living in open country they are very curious, and their curiosity has earned them a reputation for stupidity amongst trappers and shooters. It is said by such, that in winter when large "mobs" congregate on the sunny side of ridges, a dozen may be shot down one by one before the rest make up their minds to go, provided the shooter does not move from his position.

Locally it is regarded as an extremely fast wallaby, but as it is not hunted with dogs to any extent, it is difficult to get data for comparison with other species. Although I never saw one hard pushed, my own impression was otherwise; it has, ordinarily, a rather loose-jointed, high-bounding gait, which would need to be greatly flattened out before it could extend a greyhound.

Le Souef ("Animals of Australasia") has already noted its habit of standing bolt upright, and the attitude he illustrates is in no way exceptional, but is always assumed when it leaves its feeding for a moment to look about it. Even the joeys rear themselves back in the same extreme way, and are often hard pushed to maintain their balance with their weak little tails—a most ludicrous sight. When in this upright position the hips are spread more than in other species, the femora apparently sloping outwards from the pelvis at a considerable angle.

Temperamentally it is not at all shy, and in captivity is mild and gentle in its ways. Old males have little of the aggressiveness shown, for instance, by *ruficollis* and *ualabatus*.

After examining many living examples at close quarters and measuring eleven in the flesh, the following details of external characters not apparent in museum material are to be observed. All writers have commented on the slender and graceful build of *parryi;* this is largely due to its great height, the unusually long neck and sloping shoulders, and the long attenuated forelimb; the hind-quarters being very large and powerful. Even in old males the slimness of the fore-quarters is not lost; the arms may become heavily muscled, but the wide chest and great development of pectorals commonly seen in "Old Men" of *ruficollis, ualabatus* and *agilis* is not usual in *parryi*, and its body weight is notably low in comparison with its linear dimensions.

The head, in addition to its striking markings, is peculiar in other respects; it is light and delicate, long and narrow, with a slender, shallow muzzle, pinched in at the sides somewhat, near the nostrils (see plates II. and III.). The ears,

as remarked by Collett *(loc. cit.)*, are unusually large; they are bent inwards at the tip, and their inner naked portions are salmon-coloured.

The pes is exceedingly large and with a naked sole, but this is not of even width, the calcancal extremity being expanded. The toe pads are thick, fleshy and resilient. The nail of the fourth toe is large and strong and its upper edge strongly convex. The point is blunt, but is not undercut by an oblique facet of wear as in *robustus*. The fifth digit is relatively large, as in all *wallabia*, and is not reduced as in the wallaroos. (Compare Gould, quoting Strange, Mammals of Australia.)

The tail is a very striking feature, being excessively long, very mobile in life and with little lateral compression. Chevron callosities on its lower surface are not marked, but a large bare patch is generally present on the *dorsal* surface of the base of the tail.

As regards pelage, *parryi* appears to be a very uniform species all over its range; sexual, seasonal, and individual variations all being quite insignificant. Midwinter skins (August), when compared with those taken in January, show a slight increase in density on the ventral surface, but the dorsal coat remains short and rather thin and the colouration is precisely the same. It is a peculiarity of *parryi* that its epidermis, over the greater part of the body surface, is highly pigmented and appears a dark brown, or even black, on parting the fur. The coat of the fully-furred pouch young is exactly as in the adult. Hair trends generally are as in *ruficollis* (see "Trans. Roy. Soc. S. Austr.," 1930, p. 53). There is, however, in addition, a strongly developed opposition ridge on the haunch below, and nearly parallel to, the prominent white stripe in the same area.

In considering the future of this wallaby in Queensland, there are sound reasons for anxiety. It is true that it is still numerous over a large area, but no one with any knowledge of the fate of open country species elsewhere would maintain that it will long survive the present rate of slaughter in the cattle country of the Dawson. Where man is concerned its instinct for self-preservation is almost nil, and as its colouration and habits make it a most conspicuous animal at any time, its destruction is almost a mechanical matter. It is very probable that the scores of thousands of whiptails which are killed every year in coastal Queensland, represent, not the natural increase, as is assumed locally, but rather the natural drainage of the species from large areas of relatively poor feeding grounds into smaller areas which are more attractive to it and which will support a denser population. When the country is settled these "fur pockets" act as natural traps, and destruction which appears to be local actually affects a much wider area, indirectly. It is this factor of natural concentration which is largely responsible for the element of unexpected suddenness which often marks the extinction of mammal species before advancing settlement.

M. parryi is one of the most beautiful of Australian mammals, and is one of the very few species which can be easily and freely observed under natural conditions. It is to be hoped that its value will be recognised while there is still time.

Mean values for the flesh measurements of two males and two females, from Drumburle, and all with P^4 and M^4 in place, are as follows:—Head and body, 793, 732; tail, 1,077, 858; girth of chest, 470, 315; manus, 85, 54; nail of third finger, 33, 24; pes, 286, 247; fourth toe, 104, 94; nail of fourth toe, 32, 30; Ear, 105 $\times$ 53, 98 $\times$ 49; rhinarium to eye, 80, 75; eye to ear, 61, 53; weight, 49, 32 lbs.; humerus, 148, 100; ulnaradial length, 200, 155; femur, 225, 185; tibia, 330, 275.

All skulls examined show a close agreement in general features; from that of *ruficollis*, which it resembles closely when aged, it is distinguished by its narrower P^4, shallower muzzle, and greater transzygomatic breadth. In the Dawson area the skull is lightly ossified.

Mean values for the skull measurements of the above males and females are as follows:—Greatest length, 146, 137; basal length, 134, 124·5; zygomatic breadth, 75, 73; nasals, length, 61, 56; nasals, greatest breadth, 21, 21; depth of muzzle, 26·5, 23·5; constriction, 20, 19·5; palatal length, 89, 83; palate, breadth inside M^2, 24·5, 23; anterior palatine foramina, 6·5, 7·5; diastema, 38·5, 35·5; basi-cranial axis, 39·5, 36·5; basi-facial axis, 99·5, 91·5; facial index, 251, 250; M^{1-3}, 23·5, 22·5; P^4, 5, 5.

MACROPUS (W.) RUFICOLLIS, var. (Roany: bush-tail).

So far as published records go, the northern extension of the range of this wallaby is very indefinite. It was stated by Longman in 1922 to occur in South Queensland, and somewhat later specimens were obtained by him from Mundu-berra, on the Burnett.

In the Taroom district of the Dawson Valley, in about the same latitude, but west of this locality, I had frequent reports of a "roan wallaby," or "bush tail," and finally, after obtaining a single specimen on the Palm Tree Creek, was able to identify it as *ruficollis*. It is not a common species on the Dawson, and I neither saw nor had reliable reports of it further north than Drumburle.

The single example obtained, a subadult female, was shot in a heavily-grassed gum flat, in just such country as is frequented by *agilis* further north.

Although its general external characters and skull and dentition are unmistakably those of *ruficollis*, its colouration is very distinctly, even strikingly different, from the southern form. On comparison with a young female taken in the Tumut district of New South Wales, about a month earlier, these differences may be summarized thus:—

The general dorsal colour is much lighter, and a marked cinereous tone prevails owing to the reduction in number of entirely black hairs, to the fading of the black terminal band of the other hairs to a rufous brown, and the consequent greater prominence of the subterminal white band. The black pencilling of all extremities is reduced. The hair at the base is everywhere some shade of ochraceous orange, whereas the epidermal band in the southern animal is a dark brownish slate. The rufous areas of nape and rump are similar in position and extent, but the colour is paler in the Queensland animal—almost buff. The muzzle, cheeks, and crown are a clear pale rufous, almost free from brown and black admixture, and, in particular, the back of the ears are uniformly coloured a pale buff orange, the extreme tip only being brownish; in the southern *ruficollis* the apical ½-⅔ of the back of the ear is dark brown or black. The lower ventral surface is clothed with uniform cream or fawn-coloured hairs, very different from the dark slate silver-tipped hairs of the New South Wales animal.

The differences noted are quite as marked as those which separate the varieties *typicus* and *bennetti*, but I am unable to assert their constancy owing to lack of material. The accumulation of an adequate series has been undertaken, and pending its completion I refrain from giving this local form a name.

Flesh dimensions of the ♀ (P^4M^3):—Head and body, 618; tail, 727; girth of chest, 280; manus, 50; nail of third finger, 33; ear, 94 × 51; rhinarium to eye, 70; eye to ear, 53; weight, 24 lbs.; humerus, 78; ulnaradial, 132; femur, 175; tibia, 265.

Skull:—Greatest length, 130; basal length, 116; zygomatic breadth, 68; nasals, length, 53; nasals, greatest breadth, 18; nasals, overhang, 11·5; depth of muzzle, 24; constriction, 18; palate length, 77·5; palate breadth inside M^2, 22; anterior palatine foramina, 6; diastema, 27·5; basi-cranial axis, 33; basi-facial axis, 85; facial index, 258; M^{1-3}, 24·5; P^4, 7; I^1, 10 × 5; I^2, 5 × 3·5; I^3, 6 × 8.

MACROPUS (W.) UALABATUS, var. INGRAMI. (Swamper.)

This species is found throughout the length of the valley, but has a very interrupted and rather sparse distribution. It was observed and specimens obtained, in the Taroom district, at Thangool in the Callide Valley, at Coomooboolaroo

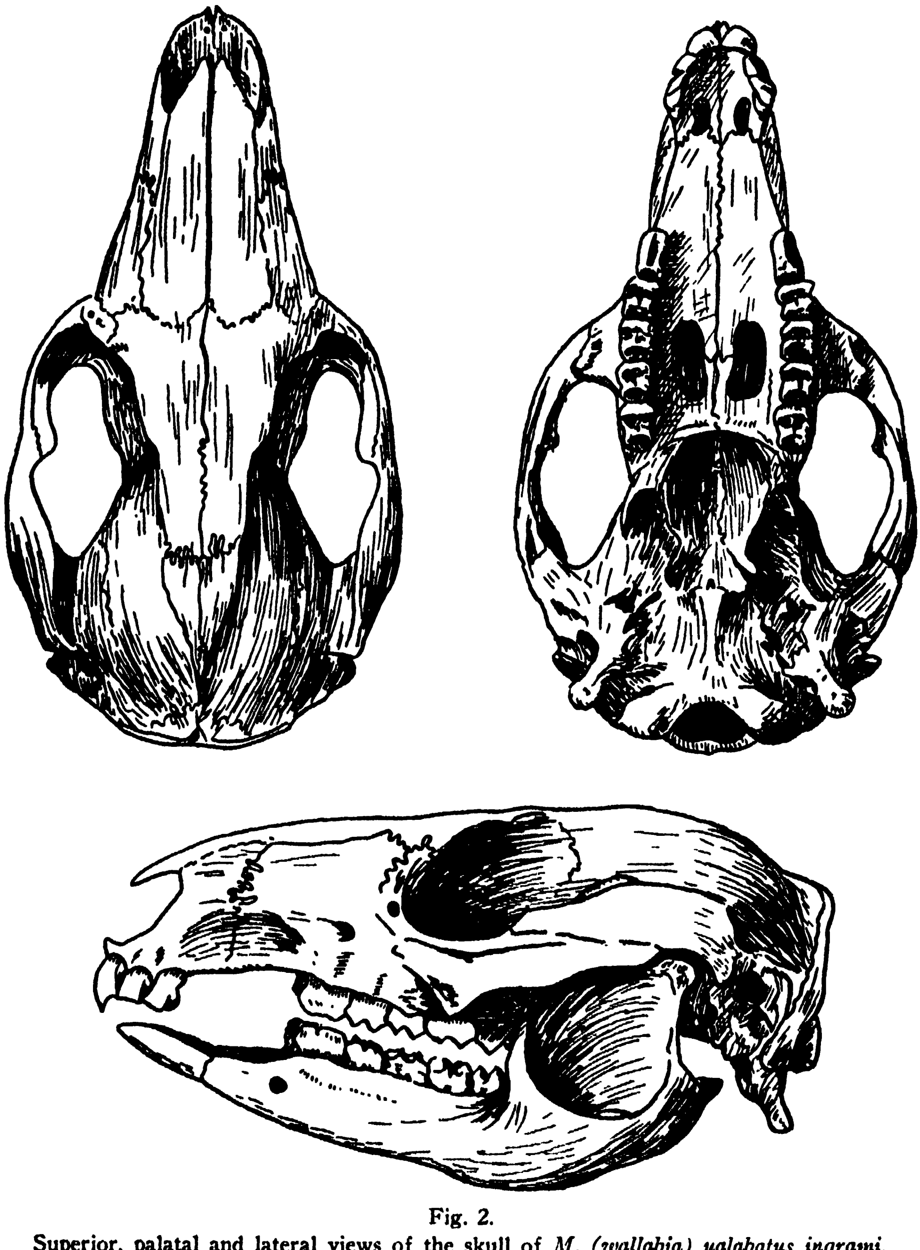

Fig. 2.

Superior, palatal and lateral views of the skull of *M. (wallabia) ualabatus ingrami.* Adult male, from Thangool. Three-quarters natural size.

and in the Berserker Hills, but in many intermediate localities, where it was sought in likely country; it was quite unknown. Further east, on the slopes of the Coast Ranges, its habitat is one of well-watered, densely-clothed and shady gullies, which,

except for the increased humidity, offer conditions quite similar to those obtaining in Gippsland and southern New South Wales, where the typical variety has its chief station. On the Dawson it has to contend with much drier conditions, and the *ualabatus* element in the fauna here, probably represents only the scattered (and fluctuating) fringe of the main body. In some places its first appearance is still remembered. Mr. Charles Barnard, the present owner of Coomooboolaroo, remembers when the first "black wallaby" was taken by the local blacks (in the early eighties) in the Dawson Range at the south end of the run, and brought in to the homestead and exhibited by them, as a great curiosity. It lives very obscurely in small scattered parties and lies up in moderately dense cover. At Thangool, where it was rather more plentiful than elsewhere, it camped on the fringes of the Brigalow scrubs and was snared on the same pads as were used by *dorsalis,* but unlike the latter it was frequently seen in the early mornings about the clearings of the settlers, feeding on the Rhodes grass.

The material obtained agrees well with Thomas's description[10] of *M. ualabatus ingrami* from Inkerman, 300 miles north of the most northerly locality from which I obtained specimens.

It is a small brightly coloured form of *ualabatus,* characterised by a great increase in the fulvous element of the colouration. The subterminal band of the dorsal hairs is longer than in *typicus,* is pale gold yellow rather than orange rufous, and the overlay of entirely black hairs is much reduced. The face markings are conspicuous, the coat shorter, and although its colours are brighter the hairs lack much of the lustre and sparkle of the southern form.

The skull is smaller than that of *typicus,* aged examples attaining a basal length of 113 mm. as against 128 mm. In general proportions and contours it is similar to that of the southern variety, and, like it, is massive and densely ossified. Significant of relationship, also, is the practical identity in size and proportion of male and female crania—a striking peculiarity of *ualabatus typicus* separating it sharply from other eastern species.

Minor, but constant, differences separating the two varieties are: (1) the relatively greater posterior expansion of the nasals in *ingrami,* the ratio length ÷ posterior breadth being only 2·36 as against 2·80 in the south; (2) the virtual absence in *ingrami* of the interorbital constriction, always very marked in mature skulls of *typicus;* numerically expressed, the ratio, basal length ÷ constriction is 6·0 in the former, 7·6 in the latter; (3) the diastema (at comparable dental stages) is shorter in *ingrami,* going into the basal length 4·8 times, as against 4·5 times in *typicus.*

The teeth, particularly the secator, are smaller and lighter in *ingrami*—considerably more so than linear dimensions alone indicate.

Unfortunately detailed flesh measurements of adults were not obtained.

The mean values for the dimensions of four adult skulls (P^4M^4) are as follows:—Greatest length, 119; basal length, 109; zygomatic breadth, 61; nasals, length, 46; nasals, greatest breadth, 19·5; nasals, overhang, 9; depth of muzzle, 23·5; constriction, 18; palate, length, 70·5; palate, breadth inside M^2, 21; anterior palatine foramina, 6; diastema, 22·8; basi-cranial axis, 33; basi-facial axis, 79; facial index, 239; P^4, 8; M^{1-3}, 20·5.

The maximum values for the teeth, derived from a series (11) of 8 *ingrami* and 15 *typicus* skulls are:—I^1 *(ingrami),* 4·5 × 9·5, *(typicus),* 4·5 × 9·5; I^2, 5·5 × 5·5, 5·5 × 6·5; I^3, 7·5 × 6·5, 8·0 × 6·5; P^3, 6·5, 7; P^4, 8·5, 10; M^{1-3}, 22·5, 23·5.

There can be little doubt that this wallaby is identical with Krefft's *Halmaturus mastersi,* obtained in about the same latitude on the Burnett in 1870.

(10) "P.Z.S.," 1908, p. 792.

(11) Antero-posterior length × vertical height (of enamel).

The name *mastersi* was given as a doubtful synonym of Günther's var. *apicalis*, by Thomas in 1888, and when the Inkerman specimens were examined in 1908 Krefft's name was again suppressed, presumably on the grounds of insufficient description.

Although it would be seemly to commemerate Krefft's priority in the matter, there appears no regular way of so doing, except by founding a new subspecies on such trifling differences as can be made out between the Inkerman and Dawson animals, and this is a very undesirable course.

It may be noticed, as an apparent anomaly, that the reduction in size of *ualabatus*, which occurs on passing from Gippsland to Central Queensland, is not continued further north; *apicalis*, from Cape Grafton, being (fide descriptions) as large as the typical form.

Subgenus *Thylogale*.

The local distribution of the small wallabies of this group in the Dawson Valley is a matter of uncertainty, owing to the fact that its presence is usually masked by the much more numerous *M. dorsalis*, which has come to occupy almost all the scrubs in which *Thylogale* might be sought. In most localities where *dorsalis* is taken in large numbers for commercial purposes, the snarers tell of a much smaller "Paddymelon" which they obtain occasionally. From its description I would identify it with *M. thetidis* or *M. wilcoxi* rather than with *Onychogale frenata*, to which, according to Longman, this vernacular name is most commonly applied in Queensland.[12]

It is, at any rate, quite certain that numerically *Thylogale* are an insignificant factor in the fauna of the Dawson Valley proper, and the only specimens which were obtained camé from the moister country on the Fitzroy.

MACROPUS (THYLOGALE) WILCOXI (?). . .

Three examples of a "small wallaby" were obtained in the Berserker Hills, where they were called "Paddymelons" by local naturalists who considered them rare, and as no *Thylogale* are listed by Collett, in spite of Lumholtz's long stay in the Rockhampton district, its rarity is not apparently a recent development. The three specimens are practically identical, and present such a mingling of the characters of *thetidis* and *wilcoxi* (as recorded) that the identification given is provisional only. Material for direct comparison has been scanty, and existing descriptions are confused and appear to be based on quite inadequate numbers from restriced localities.

In a general view the skins are nearer *thetidis* than *wilcoxi*, having the characteristic rufous nape and fore-quarters, a marked reversal of the hairs cephalad on the anterior dorsal area, and uniformly coloured ears, with no indication of the bright rufous basal patch of the New South Wales *wilcoxi*. On the other hand, the posterior and outer aspects of the lower leg and tarsus are bright rufous strongly contrasted with the grey brown of the upper leg and the pale brown of the foot and toes. In a series of *thetidis* skins from the Northern Rivers district of New South Wales there is no approach to this character, and Gould's plate of *thetidis* represents the whole of the leg as being uniform grey coloured. Thomas, in the catalogue, speaks of the arms and legs being grey or rufous. There is a faint pale hip-stripe.

The skull, on the whole, is nearer *wilcoxi* than *thetidis*, but this decision is based almost entirely on the dentition. On applying the tests given by Thomas for distinguishing the two species, to such skulls of both as are available here, it

(12) The word "Paddymelon" is of very uncertain connotation in all the States, and in the writer's experience is applied to at least eight species of marsupials. It is frequently used by bushmen, in a general or categorical sense, for animals which are strange or unfamiliar.

would appear that the characters relied upon (except those of the teeth) are so variable in both as to be quite useless for the purpose. This is true of the nasals, premaxillae, interorbital space, palatal foramen, and nasal spine.

The third incisor, however, is a considerably larger tooth in *thetidis* than in *wilcoxi*, and its anteror posterior length is distinctly greater than its height, whereas in *wilcoxi* the length is about equal to the height, or rather less. Both secator and molars are somewhat shorter and slighter in *thetidis.*

In these respects the Berserker wallaby agrees with *wilcoxi*, and as they may be given more weight than discrepancies in coat colour, I refer it to that species rather than to *thetidis*. It is plain, however, that a systematic restatement of the characters of these two small wallabies, based on a large series culled from the whole of their range, is urgently needed.

No flesh measurements were obtained, but both sexes at the P^4M^4 stage are smaller than either *thetidis* or *wilcoxi* from northern New South Wales.

Skull dimensions of a male and female, both with P^4M^4:—Greatest length, 94, 87; basal length, 86, 78; zygomatic breadth, 51, 46·5; nasals, length, 35, 31; nasals, greatest breadth, 15, 13·5; nasals, least breadth, 7·5, 7; nasals, overhang, 4·5, 3·5; depth of muzzle, 18, 15; constriction, 11·5, 11·5; palatal, length, 54, 49; palatal, breadth inside M^2, 16·5, 15·5; anterior palatine foramen, 4, 3·5; diastema, 18, 18; basi-cranial axis, 29·5, 25·5; basi-facial axis, 58·5, 53·5; facial index, 198, 209; M^{s1-3}, 15·5, 15·5; P^4, 5·5, 5·5; I^3 (in a young skull), 6 × 5·5.

Petrogale penicillata, var. herberti.

This rock wallaby is still, as in Lumholtz's time, very numerous and widely distributed. It is to be found in thriving colonies in almost every range of hills away from the large towns, and occurs indifferently whether the rock outcrops are bare or densely clothed with scrub. Like the local wallaroo, it is considerably less specialized to a life amongst rocks than some of the inland forms, and on the upper Dawson, in the broken country round the heads of the creeks, it spends much time in the patches of low scrubs, living much as the *Thylogale* do. Like them, also, it is less diurnal and more wary than *P. xanthopus* or *Plateralis,* and although it takes the sun on the rock faces in the early morning and again in the late afternoons, it does not expose itself as freely as the latter.

In spite of its black and white axillary patches and stripes it is not at all conspicuous, and in life appears a very plain, unadorned little wallaby. The general form is squat and dumpy with short, strong arms and legs, and the males become very heavy and strong about the arms and chest. Its physiognomy is very peculiar. The head (pl. i., figs. 1 and 2) is short, and at the crown is deep from above downwards, and wide from side to side. The short ears are thus set far apart, and the inter-auricular distance nearly equals the length of the ear. The rock wallaby is the only macropod in the Dawson Valley which is totally protected by law, and (possibly on this account) is regarded with little favour by settlers, and is shot freely. It is unlikely, however, to suffer any material diminution in the near future.

A series of eighteen skins from four localities in the valley, representing a north and south range of about 170 miles, has been examined. The series presents characters which agree essentially with Thomas's description of *P. herberti* ["Ann. Mag. Nat. Hist.," series 9 (17), 1926, p. 625], and one of the Westwood specimens examined by him has been available for comparison and blends perfectly with the rest. It is plain, however, that there is a much wider range of individual variation in external characters than might be inferred from the original description, and of these differences the following may be noted:—(1) The degree of tawny suffusion on the dorsum varies greatly both in extent and intensity; a point of some importance as affecting its distinction from *assimilis.* (2) The

white vertical band behind the scapular and the black axillary patch are frequently prolonged posteriorly, so as to form parallel longitudinal stripes reaching as far as the knee. In two summer skins this is almost as marked as in the central

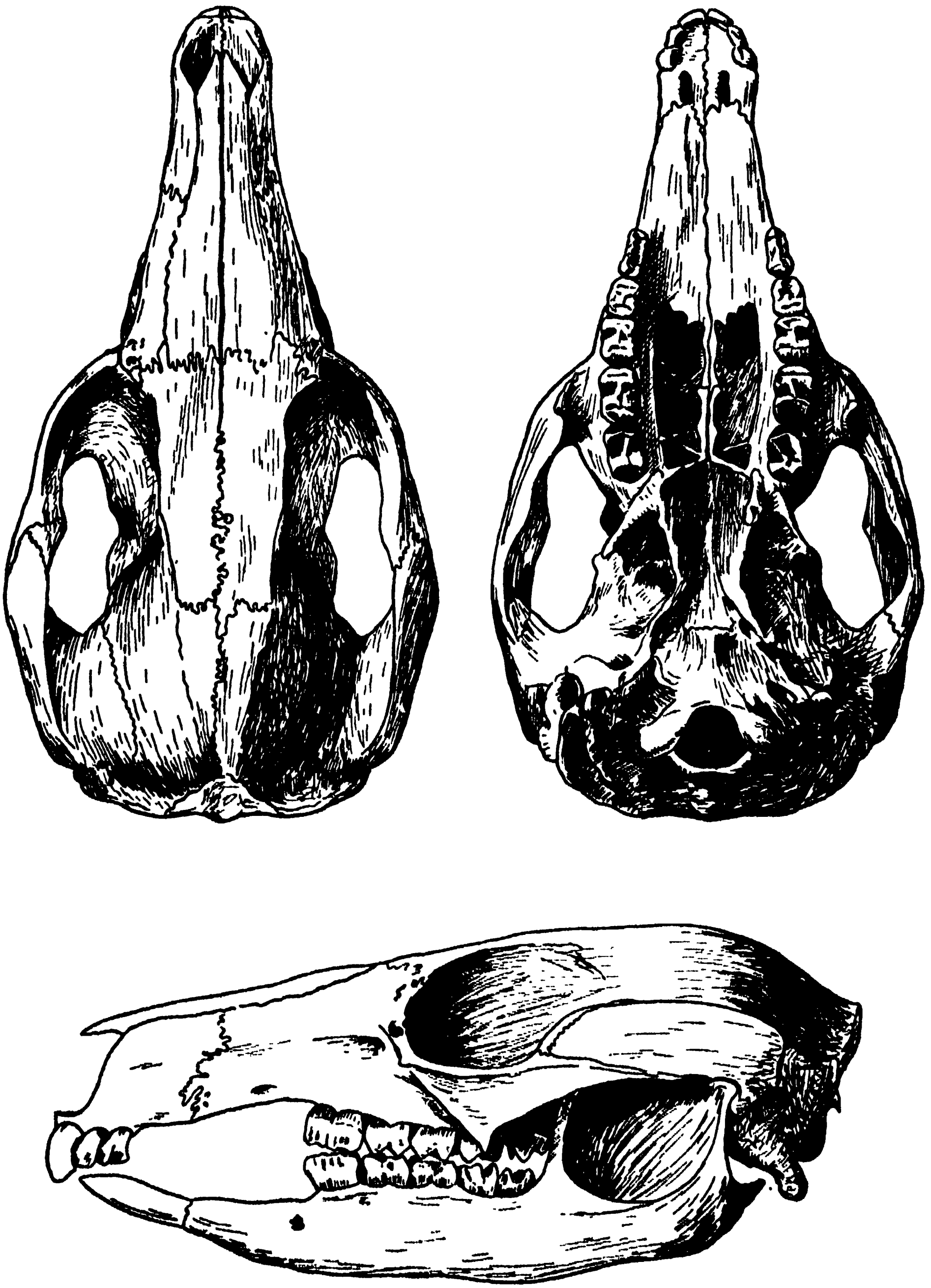

Fig. 3.

Superior, palatal and lateral views of the skull of *Petrogale penicillata herberti.* Adult male from Mount Hedlow. Slightly enlarged.

lateralis, but in others is but faintly developed. The nuchal stripe is also variable. (3) The colour of the forearm is generally some shade of yellowish brown, but may be yellowish white, and is then not distinguishable from that of the single *assimilis* available. (4) The tail may be quite black for three-quarters of its length (as noticed by Collett), or the black may be confined to the last inch or so, the remaining portion of its length between the tip and basal patch being either a grizzle of black and tawny, or almost uniform buff. Any distinction from *penicillata* or *assimilis,* based on this feature, can be of little value. All black areas tend to become orange brown. The bushiness of the tail varies a great deal; in some the hairs reach 55 mm., in others the longest hairs on the tail are but 15 mm. (5) The ventral surface, which is a variable mixture of grey-fawns, is commonly blotched with pure white. There are indications of this in specimens from all four localities, but at Morinish, 30 miles north-west of Rockhampton, it is especially pronounced, and the rock wallabies there are white-chested or even white-bellied.[18] (6) The tawny suffusion of the lower back is largely determined by the showing through of the brownish tips of the under-fur. In addition to the variability of this feature, striking differences in general appearance are also brought about by a change in the colour of the tips of the guard hairs from black to orange rufous, a much brighter colour than the normal tawny. In such specimens the dorsal colour approaches *Peradorcus.*

The series examined is a comprehensive one of about equal numbers of males and females, taken in February, March, June, August and October, and in several developmental stages. In spite of the wealth of data which it presents, I find it impossible, after careful comparisons, to correlate these variations in any definite way with locality, sex, age, or season. Some of the differences noted are, no doubt true individual variations, but others, particularly the intensity of tone and colour, prominence of markings, and texture of the pelage, probably represent merely passing phases of a cycle of change which do not synchronise in different individuals. The change of black hairs to red, for example, occurs in young as well as aged individuals of both sexes, and is quite independent of season. The two skins which represent most strongly the erythristie and cinereus stages were both taken at Mount Hedlow in June from males at the same dental stage.

The single seasonal feature which occurs in all is the great increase in density of the coat, particularly of the rich brown-black under-fur.

The skull (fig. 3) is rather variable in adult size (basal length, 100-107 mm.). As compared with the central forms, it is strongly built and densely ossified. Especially characteristic and unvarying is the wide posterior margin of the nasals; the naso-frontal suture, although very sinuous in its course, being almost transverse in its direction.

Collett's notes *(loc. cit.)* on *P. penicillata* relate to this form.

In his investigation of the *penicillata herberti, assimilis* group, Thomas has had large series of recently collected material upon which to work, and his conclusions are backed by such unique experience in these matters that one cannot doubt that the three types are recognisable, although it is plain that the distinctions relied upon are somewhat trivial, and (in the case of the northern pair) by no means constant even in a limited area, and, as Thomas himself admits, are average rather than individual characters.

In regard to the degree of separation to be accorded the forms in classification, however, there is room for other opinion. The recent description of ten new rock wallabies as full species is based on altogether insufficient knowledge and is

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(18) Mr. R. Vallis, a local naturalist, first drew my attention to this peculiarity, suggesting that the form is distinct from that further south. He was not aware, however, that the white blotching occurs in other places, and, as the Morinish wallaby is otherwise quite similar, I cannot share his opinion.

a most regrettable course, not only by reason of the confusion which is introduced in identifying such closely related forms, but more particularly on account of the lack of balance which then exists (in the literature) between these suddenly expanded genera and those which have, for purely fortuitous reasons, escaped the attentions of nomenclatorial enthusiasts. As varieties, most of these new forms would be sufficiently made known, without doing violence to the real distinctions of structure, habits and range, which separate the older species.

As Pocock has recently said ("Proc. Royal Soc., London," 1930), Thomas, in his later work, seems to have used the word species in a purely geographic sense, but even in this reduced form it cannot be applied to the *penicillata* trio, since the highlands which they occupy extend practically unbroken over the whole of their range, and the factor of isolation is absent.

For these reasons I would refer the Dawson Valley rock wallaby to *Petrogale penicillata herberti.*

Flesh measurements of an adult male and subadult female (P^4M^3) from Spring Creek, in the Taroom district, are as follows:—Head and body, 535, 515; tail, 650, 580; girth of chest, 265, 220; manus, 47, 42; nail of third finger, 12, 11; pes, 162, 157; fourth toe, 84, 78; nail, 14, 13; ear, 62 $\times$ 32, 61 $\times$ 32; rhinarium to eye, 61, 52; eye to ear, 45, 40; weight, 13 lbs., 11 lbs.; humerus, 73, 63; ulna-radial, 100, 87; femur, 145, 137; tibia, 186, 173.

Mean values for the skull measurements of 5 males and 3 females, all adult, are:—Greatest length, 108, 100; basal length, 93, 87; zygomatic breadth, 56, 53; nasals, length, 45, 42; nasals, greatest breadth, 13, 12·5; nasals, least breadth, 8, 6; nasals, overhang, 6. 5; depth of muzzle, 18, 16; constriction, 14·5, 14·5; palatal length, 60, 56; palate, breadth inside M^2, 16, 16·5; anterior palatine foramen, 6, 4; diastema, 18·5, 17·5; basi-cranial axis, 28, 26; basi-facial axis, 67, 63; facial index, 234, 234·5; $M^{s\,1-3}$, 17, 16·5; P^4, 7, 6·5.

Maximum values for the teeth derived from the series of 18 skulls are:—$M^{s\,1-3}$, 20; P^4, 7·5; P^3, 5; I^1, 4 $\times$ 8·5; I^2, 3·5 $\times$ 5; I^3, 4·5 $\times$ 5.

ONYCHOGALE FRENATA.

Observed twice only, and no specimens obtained. It was obtained by Lumholtz in the Rockhampton district in 1880-1884, and recently Longman *(loc. cit.)* has stated that it is not uncommon in South Queensland. Over the greater part of the Dawson country, however, it is either absent or rare, as few reliable accounts of it could be obtained.

LAGORCHESTES CONSPICILLATUS.

Neither specimens nor reliable accounts of this animal were obtained.

It was collected by Lumholtz 200 miles north-west of Rockhampton, and later was recorded by Thomas from Inkerman (1908).

Subfamily POTOROINAE.

AEPYPRYMNUS RUFESCENS.

This interesting animal, though highly characteristic of coastal Queensland, has received very little mention in recent years, and there has been no published data from which one might estimate its position in the fauna of that State.

Strangely enough it was not taken by Lumholtz, though it must have occurred in many of the districts in which he worked, and has thus escaped the searching examinations of Collett. It has been twice recorded from North Queensland localities by O. Thomas ("P.Z.S.," 1908, p. 788, and "Ann. Mag. Nat. Hist.," 1923, ser. 11, p. 170), and by Lönnberg and Mjöberg from Carrington ("Kungl. Svenska

Vetenskaps Akadamiens Handlingar," Band 52, No. 2, 1916), but without comment, and as each record was based on a single individual, it might be inferred to be comparatively rare.

In the Dawson and Fitzroy Valleys, however, this is far from being the case, and it is widely spread over the whole area from sea level to the tops of the plateaus. It occurs in almost all types of country, both open and forested, but never, apparently, in dense scrubs, and, like the Bettongs, it has a preference for grassy lands free from bush growth. The banks of creeks and river flats are favourite resorts, and there are few such places which by systematic beating cannot be made to yield up a few.

The nature of the country is such that it is seldom far from surface waters in normal times, and it does not hug the watercourses so much for the water as for the long grass which lines them. When, however, surface waters fail it suffers severely. Like most of the coastal species it has little resistance to drought, and will go to great lengths in excavating holes in dry creek beds to get down to water level. In January, 1929, the Cariboe Creek ceased to run at Thangool, and for miles the sandy bed thus exposed was criss-crossed with the pads of *Aepyprymnus* coming down at night to drink at pot holes of their own making.

In the cattle country it is stated by squatters to have diminished considerably in recent years, and by them it is regarded with indifference. But round many of the newly-formed cotton settlements in The Callide Valley it is plentiful, and at Thangool and Biloela and other points on The Cariboe has become an unmitigated nuisance and is cordially detested by the struggling settlers. Its raids on the crops are determined and resourceful, and as no ordinary fence will bar them for long, poisoning is the only effective check. Scores of thousands have been killed in this way, and skeletons (few and far between in Museums) are littered thickly round the cotton plots.

It is almost strictly nocturnal, and even where plentiful is seldom seen in daylight unless it is driven from a "camp." It is solitary in habit and adult males and females are not often put up together, though a female is often accompanied by a nearly full-grown young.

By most authors (quoting Gould?) it is stated to build a grass nest, but in spite of much searching in likely places none were found, and nest making may possibly be a winter industry only. It is not at all fast and is easily caught by a good dog in the open, but is an expert dodger and (as all accounts of the New South Wales animal state) makes immediately for a hollow log, if such is available.

When cornered it remains cool and fights with a deliberate and collected fury, very different from the panic usually displayed by wallabies in a similar case. When taken in box traps or snares it is a most difficult animal to handle, as it is immensely strong and active and bites and claws severely. The long rodent-like incisors are not sharp enough to make large gashes, but they are difficult to dislodge, as the animal grips with all its strength and holds on, and a painful bruised wound results.

When taken young it becomes tame and affectionate, if gently handled. Its ways, even in confinement, are full of interest, and convey, as do those of all the *Potoroinae*, a much greater impression of versatility, resource, and intelligence than is the case with the more specialized *Macropodinae*. It is capable of most unexpected movements, and is not without a sense of play. A pet which I observed at Rockhampton, when teased by tossing towards it an empty 4-ounce tobacco tin, would, while lying on its side, kick it back high in the air, with *one* foot. This it did repeatedly, changing position very neatly when the tin was thrown in from a new angle.

At night it has little fear of man, and the strange sights and sounds and smells of a bush camp can always be relied on to attract it, and if it has not been

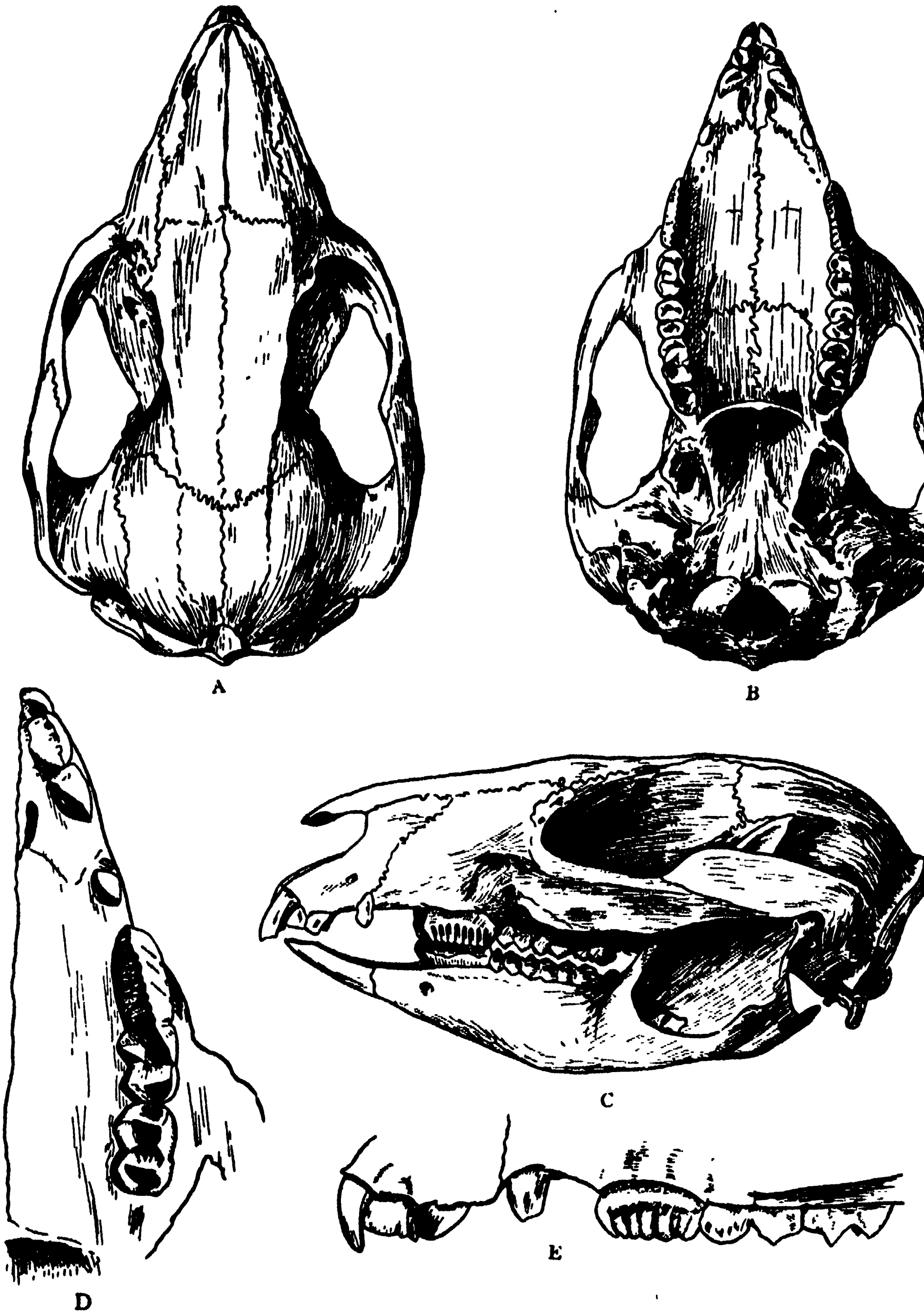


Fig. 4.

A, B, C.—Superior, palatal and lateral views of the skull of *Aepyprymnus rufescens*. A subadult female, from Thangool. Natural size.

D, E.—Palatal and buccal views of the teeth of *Aepyprymnus rufescens*, showing the characters of the incisors and the trenchant modification of the deciduous premolar (MP[4]). An immature male; 1·7 times natural size.

molested by dogs it can be enticed up to a tent door to receive scraps of food. Though largely rhizophagous under natural conditions, it becomes almost omnivorous in captivity and apparently thrives so.

When on the move it makes, at frequent intervals, a grunting sound similar, but not identical, with that of *B. penicillata.*

In March, February and January females were taken with naked pouch embryos up to 100 mm. in length.

Of external characters noted in the flesh the following may be mentioned. Bodily size at the P^4M^4 stage is rather variable, the head and body measurement fluctuating from 360-390 mm. and the pes from 130-140 mm., but contrary to Gould's statement, I find that females are appreciably larger in linear dimensions than males and are very considerably heavier (see measurements). It is not only a bigger animal than any of the Bettongs, but is relatively stouter and more strongly built, and the limbs, head, and tail are more massive. The tail is either equal to or shorter than the head and body, never longer, and it gives no evidence on inspection of a prehensile capacity or usage.

In the characters of the head it is quite different from *Bettongia cuniculus* and *B. penicillata,* but approaches *B. lesueuri* [14] in the short, rather blunt muzzle, round staring eye, and bold, insolent expression. All sets of facial vibrissae are present, but are feebly developed. All are black.

The soles of the feet, and palms of hands, are broadly naked without lateral infringement of hairs, and these parts, and all claws and the rhinarium are pale horn-coloured with no trace of black pigmentation, such as occurs frequently in *Bettongia* and *Potorous.* The inner naked portions of the auricle, on the other hand, are coloured bright orange or salmon.

In several specimens examined, the cloaca showed a heavy infestation of a dung-eating beetle.

In general the characters of the *pelage* are very constant, the texture of the fur, colouration, and markings being almost exactly the same throughout the series of 14 skins examined. They agree well, also, with the existing descriptions of the animal, all of which appear to be based on New South Wales examples. Gould's plate, however, although reproducing the gradations of colour faithfully, is too sombre in effect and does less than justice to the bright silver and russet tones of the living animal and its fresh skin.

The dark pencilling of the tail shows some variation in extent, sometimes being continued distinctly to the tip, sometimes fading out and leaving varying lengths of its distal portion pure white.

Young animals, at the P^3M^1 to P^3M^2 stage, have a denser under-fur than adults, and the characteristic black ear back is not fully developed, the contrasted area being dark rufous.

The sexes are identical, and the seasonal change, at least in adults, is negligible. Except for a gular reversal, the hair tracts retain everywhere the primitive cephalo-caudad and proximo-distad directions.

The furred pouch young, at the 350 mm. stage, is very different from the adult. The coat is harsh, closely adpressed, glossy and brilliantly coloured. The head and greater part of dorsum are a rich uniform dark rust colour, abruptly contrasted with a pure black and white grizzle on the post sacral and femoral areas.

Fourteen skulls have been examined and measured, representing stages from P^3M^1 to P^4M^4. Apart from trifling differences in the shape of the nasals, the series is a uniform one. The skull rapidly assumes a very dense ossification as growth advances and is relatively much heavier than in any other of the *Potoroinae.* No anomalies in tooth succession are presented, and no supernumerary molars are developed as they frequently are in *Bettongia.*

(14) See Wood-Jones, "Mammals of South Australia," vol. ii. p. 207.

The secator[15] appears to come into place shortly after M^3, at a stage when the general dimensions of the skull are already approaching their maxima.

In the incisor series a number of characters are presented which, though foreshadowed in *Bettongia*, as stated by Bensley, reach a development in *Aepyprymnus* quite bizarre, and which have scarcely been brought out by existing accounts. The first incisor, though not so disproportionately large in its exalveolar portion as in *Potorous*, makes some approach to the persistent pulp condition characteristic of rodent activities, in being excessively long-rooted and in retaining even in very old skulls a wide open apical foramen. In striking contrast to the same tooth in the *Macropodinae* also, it attains its maximum development late in life. The broadening from side to side of the second incisors is so great, that in young animals before the teeth are worn, they fall short of contact in the midline of the palate by less than 1 mm. (fig. 4 D). The transverse diameter of the third incisor is also greatly increased from what obtains in any of the Bettongs and, in addition, its cutting edge is rotated inwards so that it makes an angle of 60° with the long axis of the palate. The deciduous premolar (MP^4) is less molariform than in either *Bettongia* or *Potorous*, and is partially specialized as a secator by the elongation of the antero-external cusp into a longitudinal blade, the edge of which is practically continuous with that of P^3 (see fig. 4, d and e). The effective cutting edge of this combination is equal to, or slightly exceeds, that of the P^4 which replaces it.

Flesh dimensions of an adult male and a subadult female (P^4M^3), both from Thangool, follow:—Head and body, 383, 387; tail, 355, 388; manus, 28, 28; nail of third finger, 17·5, 20; pes, 141, 136; fourth toe, 62, 60; nail of fourth toe, 24, 22; ear, 55 × 30, 52 × 29; rhinarium to eye, 41, 42; eye to ear, 35, 36; weight, 5½ lbs., 7 lbs.

Mean values of the skull dimensions of five adult males, and an adult female, are:—Greatest length, 84, 83; basal length, 73·5, 72; zygomatic breadth, 51, 50; nasals, length, 28, 29·5; nasals, greatest breadth, 17, 19; nasals, least breadth, 10, 10·5; nasals, overhang, 8·5, 9; depth of muzzle, 16·5, 17; constriction, 16·5, 17; palate length, 48, 46; palate, breadth inside M^2, 18, 17; anterior palatine foramina, 3, 3·5; diastema, 10, 10·5; basi-cranial axis, 24, 23·5; basi-facial axis, 51·5, 50·5; facial index, 214, 215.

Maximum dimensions of teeth in the whole series of 14 individuals are:—$M^{s\,1\text{-}3}$, 18·5, P^3, 7, P^4, 9·5; I^1, 3 × 9; I^2, 3·5 × 4; I^3, 4·5[16] × 4·5.

Of the remaining *Potoroinae*, *Bettongia penicillata* was taken by Lumholtz on Coomooboolaroo, but has now apparently quite disappeared from there, and is not known elsewhere in the valley, and *Potorous tridactylus*, though it may occur in the wetter coastal scrubs, was not taken.

DESCRIPTION OF PLATES.

PLATE I.

Figs. 1 and 2. *Petrogale penicillata herberti.* Showing characters of head. Males from Mount Hedlow.

PLATE II.

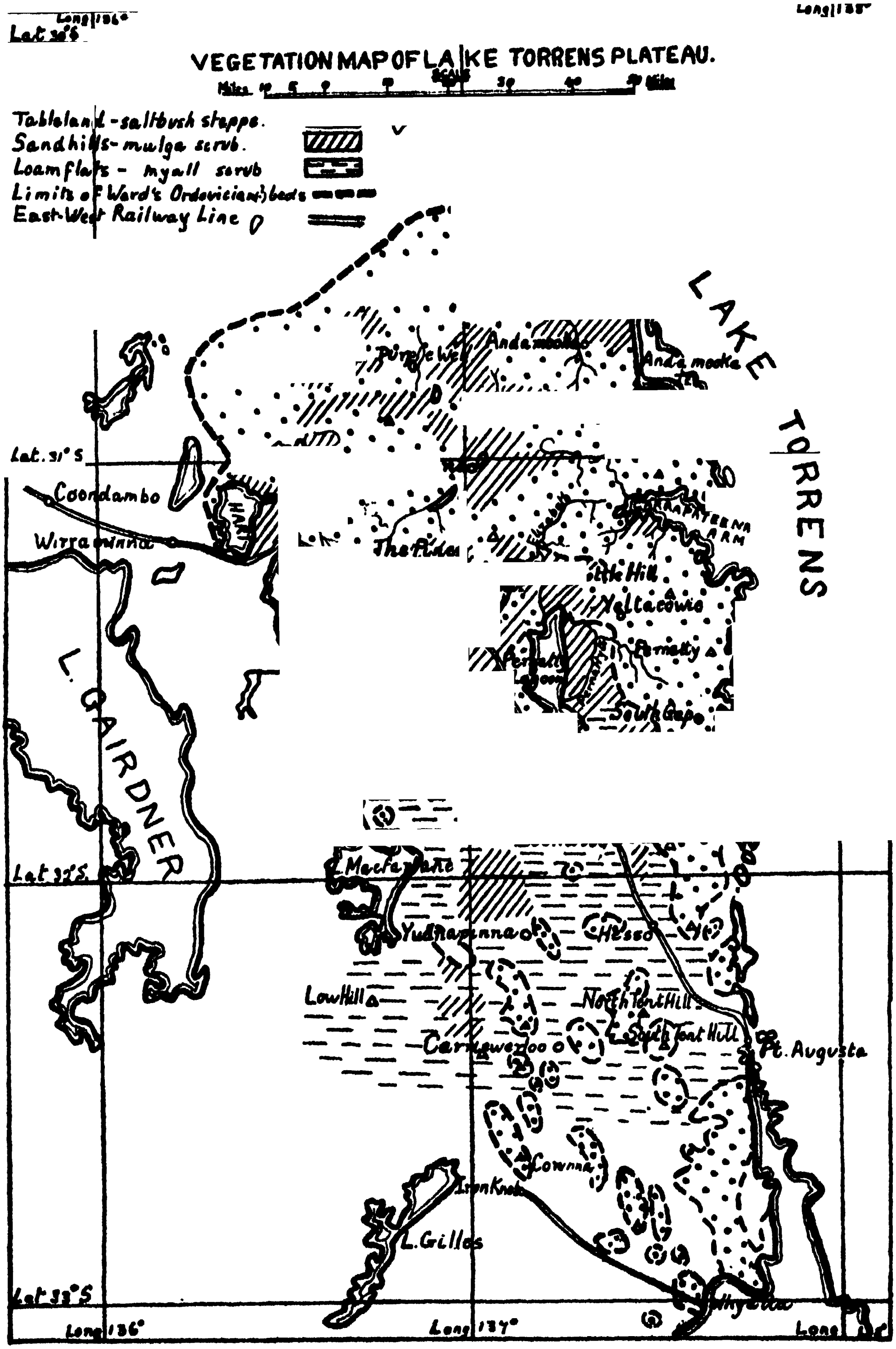
M. (wallabia) parryi. Showing characters of head. Adult male from Drumburl.

PLATE III.

M. (wallabia) parryi. Same individual.

(15) Waterhouse's statement ("Nat. Hist. of Mammalia") that the last tooth of the Potoroinae to come into place is the permanent premolar must be based on a case of delayed succession.

(16) First value is length of cutting edge, not the antero-posterior length as in more normal incisors.


VEGETATION MAP OF LAKE TORRENS PLATEAU.
Tableland - saltbush steppe.
Sandhills - mulga scrub.
Loamflats - myall scrub
Limits of Ward's Ordovician beds
East-West Railway Line
LAKE TORRENS
L. GAIRDNER
Coondambo
Wirraminna
Andamooka
Lat. 31° S
Lat 32° S.
Lat 33° S
Long 136°
Long 137°
L. Macfarlane
Yudnapinna
Hesso
Low Hill
North Tent Hill
South Tent Hill
Pt. Augusta
Carriewerloo
Cowana
Iron Knob
L. Gilles
Myall Hill
Yeltacowie
South Gap

A STUDY OF THE VEGETATION OF THE LAKE TORRENS PLATEAU, SOUTH AUSTRALIA.

By B. Jean Murray, B.Sc.
(Communicated by J. G. Wood, M.Sc.)

[Read August 13, 1931.]

Plate IV.

Contents.

I. INTRODUCTION.

The Lake Torrens plateau and surrounding country is an interesting region to a botanist, as it has not been studied ecologically before, although plant collections were made by some of the early exploring expeditions, notably those led by Babbage and Stuart. Accounts of these expeditions and pioneers of the North-West are given by Threadgill (23) and Richardson (21). The botanical collections made by Hergolt, of the Babbage Expedition, in 1858-9, were named by von Müeller (19). In more recent years Cannon (3) made a brief ecological study of the vegetation round Port Augusta and Tarcoola; Adamson and Osborn (1) described the vegetation at Ooldea, a station on the East-West Transcontinental line, 427 miles west of Port Augusta; and Cleland (4) gives an account of a journey through part of the Lake Torrens plateau and farther North-west to Mount Eba and Tarcoola; it contains plant lists and a brief description of some of the flora, including that on Andamooka.

The present paper is based on observations and collections made from 1927 to 1930, during which time all the stations between Carriewerloo and Arcoona (as far north as Young's Lagoon) were visited and the vegetation studied in different seasons. The country consists of pastoral districts mostly devoted to sheep, although, until recently, cattle predominated on the northern stations on the plateau.

The Lake Torrens plateau lies on the stable foreland to the west of the Lake Torrens faults and consists of Ordovician (?) or, possibly, older rocks which have been eroded to form flat-topped hills and stony or "gibber" tablelands; the altitude is from 500-1,000 feet above sea-level. It is surrounded by Recent to Pleistocene country (less than 500 feet) consisting mostly of loamy flats intersected by sand-ridges, salt-water lakes and lagoons and fresh-water swamps. The whole area lies between the 5- and 8-inch rainfall isohyets and is part of Tate's Eremian Region (22).

Descriptions of the topography and geology of this district are given by Fenner (6, 7), Howchin (12, 13, 14), Gregory (10), and Jack (17). Ward (24) gives the composition of the beds of the plateau as, "dolomitic limestone; quartzite with shaly bands; greenish shale weathering brown; massive siliceous

conglomerate. No fossils known"; and that of the sedimentary beds surrounding it as, "Unconsolidated sand of coast and interior; consolidated sand dunes; saline, gypseous and calcareous earths; travertine limestone; river, lake and swamp deposits; lateritic ironstone; vegetable earths; gravels of outwash fans."

The eastern boundary of the plateau is Lake Torrens, which Madigan (18) has proved to be quite dry, with patches of glistening white salt. After heavy rains it may hold a little water, in places, but this is soon evaporated.

II. CLIMATIC FACTORS.

This region is situated within the typical flask-shaped arid belt determined by the trade winds, and converges towards the southern with the southern boundary of this arid belt (11). The country dealt with in this paper lies between the 5- and 8-inch isohyets to the north and south, respectively. The rainfall over this area is uncertain and influenced both by monsoonal summer rains and winter rains of Antarctic origin; there are no regular wet and dry seasons, and rain is almost as likely to fall in one month as in another; there is perhaps (particularly towards the southern end of the region) a slight preponderance of winter rains with June as the wettest month, whereas in Central Australia it seldom rains during the winter.

TABLE I.

MEAN MONTHLY RAINFALL IN POINTS (100 = 1 INCH).

		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Purple Downs	25	47	56	45	35	89	95	42	41	76	37	68	54	685
Arcoona	39	55	51	38	41	79	88	39	33	61	38	46	38	607
Oakden Hills	46	49	45	35	58	74	92	49	56	68	55	64	47	692
South Gap	46	47	50	42	52	85	86	48	54	59	46	57	50	676
Whittita	45	51	48	43	58	84	99	57	63	66	48	50	50	717
Farina	50	53	53	68	42	67	90	37	42	47	48	48	58	653
Port Augusta	69	54	50	72	77	114	117	71	87	95	85	69	59	950

[Figures kindly supplied by Mr. E. Bromley, Government Meteorologist. Yearly records up to 1917 are given by Hunt (16).]

The average rainfall on most of the sheep stations visited is from 6·5 to 7 inches per annum; this is to some extent misleading, for should the country be assured of its average annual rainfall it would be in a much better condition, but good seasons alternate with periods of severe drought when the rainfall may drop to less than 2 inches in a year, to be succeeded by years of greater rainfall until a climax is reached. These very wet years restore the ravages of drought, fill the dams, wells, and waterholes. Thus the reliability of rainfall is poor throughout the area which lies between the isopleths showing 20% to 30% variation from the average amount of rainfall and verging towards 40% variation at the north end of the plateau. Another feature of the rainfall is the manner in which it falls; in some instances the whole year's rainfall may fall within a few days, while in others it may be scattered through several months in a number of ineffectual falls (3).

TABLE II.

DISTRIBUTION OF ANNUAL RAINFALL.

	Arcoona.	Oakden. Hills.	South Gap.	Whittita.
Highest number of wet days per annum	26	43	38	41
Lowest „ „ „ „ „ „	9	16	16	13
Mean „ „ „ „ „ „	17	30	24	31
Number of Years in Mean	20	34	34	32
Mean annual rainfall (in points)	607	692	676	717
Highest annual rainfall (in points)	1392	1403	1368	1845
Lowest „ „ „	138	182	168	173

(Figures for the first four items only available up to 1915; last three up to 1928.)

No reliable figures for the temperatures are available. The area lies between the 65° and 70° isotherms, and the nearest meteorological stations are at Port Augusta and Farina which have annual mean maximum and minimum temperatures of 77·2° and 55·3° Fahr., and 80·6° and 54·2° Fahr., respectively. Isotherms showing mean monthly temperatures throughout this region are given by Hunt (15). February is the hottest month. Even in summer there are considerable extremes of temperature, the intense heat of the day being rapidly lost at night by radiation, which is very great in such exposed regions; while in winter the extremes of heat and cold are still greater, and ground frosts fairly common on clear nights during one to four months of the year. Owing to the high temperatures throughout the year, the dryness of the air, and the prevalence of drying winds, the rate of evaporation is very great, this area lying between the 60″ and 80″ isatmics. Managers of some of the stations visited estimate the evaporation of the big dams and waterholes as at the rate of 12 feet per annum; and Howchin (13) gives 100 inches per annum for the amount of evaporation in the arid country round Lake Eyre.

Where the variation in temperature is negligible the main characteristics of the vegetation of a region are determined chiefly by the amount of rainfall and its reliability. By these Tate determined the outlines of his Eremian or arid region; and Wood (26) gives the 8-inch isohyet as the lowest margin for the occurrence of mallee in South Australia. In the Lake Torrens District mallee is a climatic indicator only found towards the south-western boundaries of the southern stations, such as Carriewerloo and Yudnapinna, through which the 8-inch isohyet passes. Between the 8- and 5-inch isohyets no mallee occurs, and the vegetation, which is of the arid type, is fairly uniform in character, differences in the associations being due mainly to edaphic and not to climatic conditions. Perhaps the reliability of the rainfall has more effect in determining the constitution of the vegetation than the actual amount; a region with an average rainfall of 6-8 inches of normal reliability could support a much less arid vegetation than one where, as in the case of this district, the reliability varies up to 40% from the normal, and wet seasons are widely separated by long dry seasons, tending to increase the xerophytic character of the flora.

The vegetation, particularly the therophytic or annual, is noticeably affected by the season in which rain falls. The wealth of herbage produced by winter and spring rains differing largely in constitution (being chiefly composed of Cruciferae, Leguminosae, Zygophyllaceae and Compositae) from that (mainly grasses) growing after summer rains. Certain plants will only develop or flower if rain falls at the particular seasons favourable to them, *e.g.*, the parakeelya and *Crinum pedunculatum*.

III. EDAPHIC FACTORS.

(A) Habitats.

There are three main types of habitat in the district:—

1. The gibber tableland; also characteristic of the tops and sides of the flat-topped hills.
2. The red sandhills.
3. The loamy or sandy flats and claypans between the sandhills and surrounding the plateau.

The gibber tableland comprises most of the plateau and corresponds in extent and boundaries very closely with the area marked "Ordovician" (?) by Ward (24). The gibbers are reddish-brown in colour, of all shapes and sizes, but usually flat and angular, about four inches across by a half to one inch thick; with age and weathering they tend to become rounded and smooth; in some parts younger

Eyrian gibbers may be found (17). The mantle of gibbers acts as a natural mulch; beneath them the soil is red, argillaceous or loamy and of considerable depth (some feet). It collects, without gibbers, in depressions to form "crab-holes" or small swamps.

The sandhills on the plateau may be from 30-40 feet high or less and usually lie at right angles to the prevailing winds, generally in a north-easterly to south-westerly direction; they consist of fine to coarse siliceous particles, red in colour. They are separated by loamy or sandy flats or claypans of varying size. The latter have a retentive floor and may hold fresh or salt water for a short time after rain; some are more extensive and form "playa"-lakes or salinas.

The district surrounding the plateau on the south and extending to and around the numerous lakes and lagoons around the Island Lagoon, which marks the western boundary of these investigations, consists chiefly of undulating country or flats of light red sandy loam or red sandy soil, between red sandhills, or with patches of scattered sand-ridges. Both these sandhills and flats resemble those to be found in certain localities on the tableland (see map), but they are usually of greater extent and the soil on the flats is usually deeper.

There are no permanent water-courses throughout the district, which is outside the great artesian water system (17); but some of the larger gum-creeks, such as the Elizabeth, Pernatty, and Whittita Creeks, may hold water for a considerable time after heavy rains. The tableland and numerous hills and bluffs are drained by smaller stony acacia creeks, which only flow after rain but do not retain water for long.

B. Soils.

The soils of the Lake Torrens plateau and environs have not been properly investigated yet, but appear to be the typical red soils developed under insufficient moisture conditions characteristic of similar dry regions in sub-tropical latitudes and warmer regions of the temperate zone in other parts of the world, *i.e.*, South Africa, Spain, and the dry steppes of Russia and round the Caspian Sea (8). As Glinka (8, 9) pointed out, whatever the origin of the rocks subjected to sim'lar climatic conditions the soils eventually produced from them will be very similar, and this is the case in this region.

The water-retaining capacity of the various soils in this region is considerably less than that given by Wood (26) for typical saltbush, bluebush, and mallee soils outside the 8-inch isohyet. The amount of water at saturation in typical soils from Oakden Hills Station is given below:—

Table III.

Water at Saturation

Locality.	Amount of Water.
Tableland (saltbush soil)	24·0%
Gypsum (growing saltbush)	30·5%
Limestone knoll (myall and bluebush)	22·0%
Loam flat (myall and bluebush soil)	19·0%
Claypan	22·5%
Claypan, Pernatty Station	22·5%
Dry swamp (lignum)	18·5%
Sandhill (mulga soil)	16·5%

Because of the small amount of moisture the vegetation is not well developed, and consequently there is little humus in the soil, which is always alkaline. The author is indebted to Professor Prescott and his staff at the Waite Institute for the analyses of the soil samples given in the following table:—

TABLE IV.

ANALYSES OF SOILS.

	pH. Value.	Total Salts.	Na Cl
Tableland—Saltbush and samphire.			
1. Woocalla: *(a)* Gibbers over dark red clayey soil ..	7·9	0·59	0·27
(b) Ironstone gibbers, red clayey soil .	8·6	0·18	0·01
2. Top of South Oakden Hill, samphire and saltbush, gibbers over red clayey soil	7·7	1·23	0·97
3. Pernatty, gibber plain, no vegetation, polished gibbers over red sand to depth of 4 cm., then clay	7·8	1·13	0·88
Loamy flat, Whittita—Saltbush, mostly dead. Profile taken from sides of dry sandy creek, washed out in loam flat.			
(a) Coarse red sand over light bright-red sandy soil, 3 cm.	8·1	0·06	0·01
(b) Dull, darker reddish-brown soil, fine particles, 20-29 cm.	8·5	0·03	trace
(c) Subsoil, dark bright-red, hard, some scattered stones of various sizes up to 4 cm. long; patches of white throughout, over 40 cm. ..	7·8	1·41	1·25
(d) Below, damp dark red soil	8·2	1·19	0·97
Loam flat, Yudnapinna—*Eremophila glabra*, saltbush and bluebush *(Kochia sedifolia)*.			
Sandy loam, coarse sand over fine particles, 13 cm.	8·3	0·07	0·01
Loam flat, Oakden Hills—Myall and bluebush *(K. sedifolia* and *K. pyramidata)*	9·0	0·10	0·02
Toby's Swamp, Pernatty — Canegrass flat *(Glyceria ramigera)*.			
Red sand to depth of 4-6 cm.; black soil below ..	8·4	0·12	0·01
Edge of swamp, Pernatty—Gums *(Eucalyptus rostrata)*.			
(a) Whitish sand	8·5	0·03	trace
(b) Hard greenish-white patch in sand, no vegetation	8·3	0·07	0·02
Claypan, Pernatty—No vegetation.			
Hard light red clay	7·9	0·35	0·20
Swamp, Oakden Hills—Canegrass, samphire and typical mixed swamp flora.			
Clay, brown and cracked on surface, 1-2 cm.; red clay below, 4-6 cm.	8·3	0·45	0·09
Lake Torrens, South Gap.			
1. Sample taken on lake, 100 yards from shore.			
(a) To 24 cm.	Large amount of gypsum		
(b) Below 24 cm.	8·6	high	5·30
2. Sample taken on shore two yards from edge of lake — Samphire *(Arthrocnemum halicnemoides* var. *pergranulatum)*.			
Sand	8·0	1·00	0·63
3. Sample taken on shore, 60 yards from edge of lake—Samphire, saltbush and bluebush *(K. tomentosa* var. *appressa)*.			
Sandy soil	8·2	0·05	0·01

The following was obtained and analysed later by the author:—

	pH. Value.	Total Salts.	Na Cl
Sandhills, Oakden Hills—Mulga.			
Bright red sand for a considerable depth		0·50	0·03

It will be seen that the alkalinity of the soils is high; and in many cases the percentage of total salts is high also, possibly owing to the frequent occurrence of gypsum throughout the district as well as the large amount of sodium chloride present in many soils, accounting for the halophytic character of the vegetation, *i.e.*, the general occurrence of samphire on the tableland; the saltbush *(Atriplex vesicarium)* is also more tolerant of salt than the bluebush *(K. sedifolia)*, which usually only occurs in crab-holes or towards the edge of the tableland.

IV. ANALYSIS OF THE FLORA OF THE REGION—FLORISTICS.

(A) Origin and Distribution of Species.

This region is part of Tate's Eremian Region of the Australian Flora (12, 22). In Cretaceous times, when the endemic flora of Australia arose, the Lake Torrens plateau was doubly cut off from the migration of species from the west (25); when the Cretaceous seas receded, the climatic changes of the Tertiary period were already bringing that increasing aridity which has since proved such an effective barrier against invasion from the south-western flora. It, therefore, seems apparent that at least for long periods of time migration from the west into this limited area must have come from the south by way of the narrow coastal belt. On the other hand, eastern communications with this area were never completely severed. The relationships between the percentages of species found also in West and East Australia are almost identical to those quoted by Wood (27) for the Flora of the Gulf Region of South Australia, thus pointing to the same sources of origin. These figures are all the more striking because the individual composition of the floras is very different.

Three hundred and eighty-seven plants are recorded for the Lake Torrens Region. Fifty-six Natural Orders are represented, including 177 genera containing 372 species, of which 17 were only found in a varietal form; in addition there were 15 varieties of species already found there, and 15 were introduced plants.

Table V.

Distribution of Species throughout Australia.

		%	*Gulf Region. %
Total number of species found in Lake Torrens region	387	—	—
Number of species found also in Eastern Australia	316	80	84
Number of species found also in Western Australia	172	44·5	46·5
Western Australian species found also in Eastern Australia	156	40	41
Species found in Eastern Australia but not in Western Australia	150	39	40
Species found in Western Australia but not in Eastern Australia	17	4·5	3
Species endemic to South Australia	31	9	13
Species found also in Central Australia	72	18·5	—
Species found also in North and Tropical Australia	32	8	—
Species found throughout Australia, chiefly in warm dry parts of Temperate Australia	80	20·5	—
Cosmopolitan species	5	1	—

*In the last column of this table corresponding figures for the Gulf Region based on Wood's figures (27) are given for comparison.

Although having most in common with the arid flora of the Far North and with that of the adjacent Flinders Range, it will be seen from the following table, based on localities given by Black (2), that most of the species found on the Lake Torrens plateau are widely distributed throughout the drier parts of South Australia.

Table VI.

Distribution of Species throughout South Australia.

	Total.	%.
Total number of species in Lake Torrens region	387	—
Number common with Far North	237	61
Number common with dry northern districts	43	11

	Total.	%.
Number common with Far North-West	99	25
Number common with western region from Port Augusta to Ooldea	132	34
Number common with Flinders Range	170	44
Number common with Murray Lands	154	39·5
Number common with North-East and East	75	19
Number common with Southern region	67	17
Number common throughout the State	39	10
Endemics found only in the Lake Torrens region (including 3 undescribed varieties)	7	2

Only 43 (including 4 varieties) of the 657 species listed by Wood for the Gulf region are found also in the Lake Torrens region; but 170 species (including 8 varietal forms) are shared with the Mallee region which lies between the 8- and 20-inch isohyets, and for which Wood (26) gives a total of 590 species. Out of 188 species given by Adamson and Osborn (1) for Ooldea, on the Nullarbor Plain, 95 are shared with the Lake Torrens region, which has a similar climate.

(B) Endemics, Restricted and Compound Species.

The following endemics are found only in the Lake Torrens district:—*Swainsona Burkittii*, *S. adenophylla*, *Phyllanthus rhytidospermus;* also a new genus of Borraginaceae (*Embadium stagnense* J. M. Black), a weeping variety of *Acacia Sowdenii*, which itself only occurs from Port Augusta to Ooldea, a succulent variety of *Euphorbia eremophila* and, possibly, a new species of *Bassia*.

Other South Australian endemics of very limited distribution recorded for this district are:—*Thysanotus exiliflorus*, *Amarantus Mitchellii*. var. *grandiflorus; Hakea cycloptera* (19), *Thryptomene Elliottii*, *Minuria annua*, *Anacampseros australiana*, and *Dimorphocoma minutula*. The last two are monotypic genera. While other species, not endemics, of limited distribution in the State found in this district are:—*Cyperus enervis*, *Heleocharis multicaulis*, *Eucarya spicata*, *Trichinium erubescens* (4), *Sisymbrium erysimoides*, *Lepidium pseudo-ruderale*, *Acacia Burkittii*, *Zygophyllum prismatothecum*, *Hermannia Gilesii*, *Verbena supina*, *Eremophila Paisleyi*, *Trichodesma zelanicum*, var. *latisepalum; Helichrysum Cassinianum*, and *Calocephalus Sonderi* (19).

The number of species is high in certain dominant genera (*e.g.*, *Atriplex* has 17 species and varieties, *Bassia* 16, *Kochia* 15, *Eremophila* 13, *Acacia* 11, *Zygophyllum*, and *Helipterum* 9), while normally the rate is low, even including varieties as distinct for purposes of comparison (2·2 species per genus). Many of the more successful species are in a great state of variability; 17 species were found in varietal forms only, while 15 varieties of species also present were found. The genera *Eragrostis*, *Swainsona*, *Sida*, and *Brachycome*, and the species *Atriplex vesicarium*, *Acacia aneura*, *A. Sowdenii*, *Cassia Sturtii*, and *Euphorbia eremophila* being particularly noticeable in this respect. No doubt these are all compound species or linneons, and in some cases several distinct jordanons have been described; the numerous forms noticed in *Atriplex vesicarium*, *Kochia tomentosa*, *Acacia aneura*, and *Cassia Sturtii* need investigating to show whether they are jordanons, hybrids or epharmones, but as they are usually found growing more or less together in similar habitats, it is most likely that they are hybrids between two or more jordanons.

Atriplex vesicarium, the common saltbush, is a particularly variable plant, and much research is needed to separate the various strains; pastoralists recognise them when they point out various kinds as more or less palatable to sheep—all of which would be classified without hesitation by a systematist as *A. vesicarium*.

The chief distinction appears to be in the size of the leaves, and in some measure in the size of the bladder or appendage on the fruits which gives the plant its name of "bladder saltbush." The most common kind found on the tableland, and the one most liked by sheep, has very small leaves and large spongy bladders on the fruiting bracteoles. Sheep apparently do not care much for the type with larger leaves which usually has much smaller or often no appendages on the fruits; this form approaches to *A. paludosum,* which also has a form (var. *appendiculatum)* that often has a small appendage on the fruiting bracteoles and is a form connecting this species with *A. vesicarium* (2). The two forms are evidently closely related, *A. paludosum* and the forms, possibly hybrids, of *A. vesicarium* most closely approaching it being unpalatable to sheep, which are partial to the more typical *A. vesicarium* forms. *A. paludosum* was not found by the author, although recorded for Beda near Lake Torrens (19).

Crotalaria dissitiflora exhibits an epharmonic desert form, only producing its three leaflets in damp localities or after an exceptionally rainy season. *Cassia eremophila,* var. *platypoda,* may also be an epharmone, while a new succulent, normally leafless form of *Euphorbia eremophila* is being studied to see whether it be merely the tableland epharmone, a true jordanic variety, or distinct species. *Anguillaria dioica,* found on the tableland at Yeltacowie, had typical pinkish-white flowers, while those found about 30 miles away, on a sandy bluebush flat at Arcoona, had greenish-yellow flowers with a brown gland, and the plants were much larger; the two types were never found growing together.

V. ANALYSIS OF THE VEGETATION OF THE REGION—ECOLOGICAL.

(A) LIFE-FORMS.

In Table 8 is given the biological spectrum of the vegetation of the whole Lake Torrens region, together with those of the vegetational units found on the various habitats. For comparison the "Normal or World Spectrum" is shown, also that for the somewhat similar arid region at Ooldea, and that for the Mallee region which lies outside the 8-inch isohyet and forms the southern boundary of the Lake Torrens region. There are no other spectra of the vegetation of arid regions in South Australia available at present.

TABLE 7.

SPECTRUM OF LAKE TORRENS REGION.

	No. of Species.	MM.	M.	N.	Ch.	H.	G.	Th.	E.	S.
Normal	400	6	17	20	9	27	3	13	3	1
Mallee (26) ..	600	—	13	30	19	11	3·5	21		
Ooldea (1) ..	188	0·5	19	23	14	4	0·5	35	4	—
Lake Torrens region	387	1	10	24	17·5	11	1·5	32	2	0·5
Gibber tableland	156	1	14	25·5	13	8·5	0·5	33·5	2·5	1
Sandhills ..	106	—	18	24·5	9	12	1	31	3·5	--
Loam or sandy flats	121	—	17	20·5	11·5	14·5	1·5	31	3	—
Claypans ..	33	6	12	30	15	6	3	27	—	—
Fresh-water swamps	155	1	4	19·5	18	15	—	42·5	—	—
Salt-water swamps	13	—	7·5	69	15	—	—	7·5	—	—

The most noticeable feature of the spectrum of the whole Lake Torrens district, also of its constituent plants, as compared with the normal, is the very high percentage of low, woody plants, chaemophytes and smaller nanophanaerophytes, and of the ephemeral plants or therophytes, while the hemicryptophytic percentage (mainly represented by grasses) is very much lower. It will be seen from a comparison of their spectra, that this region is more or less intermediate between Ooldea and the Mallee.

(B) Main Associations.

In this district are to be found three distinct types of vegetation to be correlated with the three main habitats already described, *i.e.*:—

(*a*) Saltbush steppe on the gibber tableland and flat-topped hills.
(*b*) Mulga scrub on the sandhills.
(*c*) Myall scrub on the loam flats between the sandhills on the plateau and covering larger areas beyond its limits.

In addition there are distinct associations on the claypans, round fresh-water swamps and dams, and round salt-marshes, lakes and lagoons. These are somewhat similar to those described for arid New South Wales by Collins (5).

(1) Vegetation of the Tableland.

(*a*) *Saltbush Association.*

About two-thirds of the whole Lake Torrens plateau consists of undulating, stony country coated with gibbers and known locally as "the tableland." The stations of Arcoona, Yeltacowie, and South Gap consist very largely of this tableland country. It is characterised by a low, grey, scrubby vegetation, which stretches for miles in a wide unbroken expanse; for, except along the water-courses and in depressions of the small crab-hole type or larger "dongas," there is a complete absence of trees or shrubs of any size.

The dominant plant on the gibber tableland is the "bladder saltbush," *Atriplex vesicarium*. This is the main fodder plant or stand-by of the semi-arid country, and can withstand very dry conditions owing to its mealy grey leaves, the swollen epidermal cells of which are a protection against excessive sunshine and evaporation, and also absorb the heavy dews of this semi-arid region during the long intervals between rains. The gibber covering of the tableland also serves as a sort of natural mulch, shading the soil and protecting it from drying out, and conserving the dews for the use of the surface roots of the saltbush and other xerophytic plants which are able to withstand excessive insolation and dry conditions.

The saltbush may exist in almost pure association, forming a stable climax community of the open type for most of the year but mixed with a therophytic flora after the rainy season. On the other hand, it may be associated with other xerophytic plants of the same type, *i.e.*, "tomentose microphylls," chiefly species of bluebush such as *Kochia sedifolia*, *K. pyramidata*, *K. aphylla*, *K. Georgei*, *K. tomentosa*, *K. spongiocarpa*, *K. ciliata*, *K. eriantha*, *K. excavata*, var. *trichopoda;* "bindyi," including *Bassia ventricosa*, *B. intricata*, *B. obliquicuspis*, *B. divaricata*, *B. paradoxa*, and *B. pachyptera; Frankenia serpillifolia*, and composites such as *Ixiolaena leptolepis*, *Minuria Cunninghamii*, and *M. denticulata*. Other common plants in this association are the samphires (*Arthrocnemum leiostachyum* and *Pachycornia tenuis*), pigface (*Mesembryanthemum aequilaterale*), *Trichinium obovatum*, *Swainsona stipularis* ("Vetch"), and *Abutilon halophilum*. Various tuft grasses occur among the saltbush in many places, Mitchell grass (*Astrebla pectinata*) being the most important. This is fairly common on the tableland, especially towards the northern end, but towards the southern end it appears to occur in localized patches; it is a valuable fodder found throughout the Far North and Far North-West, but is probably confined to the drier regions and limited by the 7-inch isohyet.

The therophytic part of this association is dependent upon the season when rain falls. After winter rains the "annual saltbush" (*A. spongiosum* and *A. halimoides*), *Blennodia narsturtioides* and other Cruciferae, *Zygophyllym ammophilum* and *Z. prismatothecum* are among the first to appear; then numerous composites

such as *Brachycome pachyptera, Senecio Gregorii, Helipterum polygalifolium, H. corymbiflorum,* and ephemerals like *Dimorphocoma minutula, Minnuria annua,* and *Helipterum pygmaeum; Erodium cygnorum, E. cicutarium, Daucus glochidiatus,* and the "poison-weed" *(Lotus australis,* var. *parviflorus)* also occur; then various grasses make their appearance. These are more abundant after summer rains, when numerous succulent plants also occur, such as "munyeroo" *(Portulacca oleracea)* and the rather rare "kunyami" *(Anacampseros australiana),* both splendid fodder plants; the latter was found on South Gap, near Lake Torrens. *Trichinium nobile* is not uncommon, and *Euphorbia Drummondii,* known locally as the "belladonna plant," is fairly abundant and considered poisonous to stock. A curious plant found on the tableland on South Gap, Yeltacowie, and on the top of South Oakden Hills was a leafless, brownish succulent-stemmed form of *Euphorbia eremophila,* the typical form of which was only found in creek beds on the tableland, though it was common on the sandhills and round swampy places. *Zygophyllum fruticulosum* and *Gumniopsis quadrifida* ("star-bush") frequent poor country where there is an abundance of gypsum, as around Pernatty Lagoon.

The most interesting feature of the saltbush association on the tableland is the frequent occurrence of samphire (chiefly *Arthrocnemum leiostachyum* and *Pachycornia tenuis)* among the saltbush (pl. iv., fig. 1). In other arid and semi-arid regions of South Australia samphire is confined to areas round swamps and marshes, chiefly of a salty nature. Here it occurs exposed on the open tableland far from any swamp or lagoon, though it is frequent, with other species, round both fresh- and salt-water swamps and lagoons; it is also prominent on top of dry, stony, flat-topped hills such as South Oakden Hill, and is particularly abundant in places where drought or over-stocking has deplenished the saltbush. It will be clear from Table 4 that the soils of much of the tableland and flat-topped hills have a very high percentage of total salts and sodium chloride, which evidently accounts for the presence of these very halophytic plants away from their usual habitat, and also points to the high tolerance of salts in the saltbush. It is probably for this reason that the bluebush *(Kochia sedifolia),* although considered more xerophytic than saltbush (1), does not occur frequently on the main tableland. Moreover, the tableland, with its mantle of gibbers acting as a mulch to protect the soil, is really a less xerophytic habitat than the porous, unprotected soil of the open Nullarbor Plain where the bluebush is dominant; and so it favours the establishment of the dominant salt-tolerant saltbush, except in cases where the natural balance of the vegetation has been upset or where local edaphic conditions favour the bluebush.

(b) Succession and Regeneration.

The climax association of the gibber tableland as indicated by the saltbush is of a stable nature, and under natural conditions is able to withstand severe drought conditions; while it may actually benefit from the effects of controlled grazing, continuous grazing over long periods disturbs the proportion of the saltbush and paves the way for subdominant species such as samphire, bluebush, and bindyi. The occurrence of a drought aggravates these conditions, and as samphire is even more xerophytic than saltbush the latter is to some extent choked out. Another danger of over-stocking is that not only is the established saltbush eaten out, trampled down and prevented from fruiting, but the intense insolation and great radiation of heat from the exposed gibbers hinders the growth of seedlings which would normally thrive in the meagre shade of the saltbush and other low shrubby plants, and those that do survive are immediately eaten off, so that the natural process of regeneration is cut off at its source. On the gibber tableland there is not the same danger of drifting sand and the deterioration of "eaten-out"

country by wind erosion that there is on the loam and sandy flats and sandhills; but it will soon revert to bare, dry, useless, stony plains unless set aside for a number of years for natural regeneration to take place—that is provided the process of depletion has not been carried too far first.

The first colonizers of a bare, eaten-out gibber paddock are species of bindyi, annual saltbush, chiefly "pop saltbush" (*A. spongiosum* and *A. halimoides*), mixed with other annuals, according to the season; then comes the samphire; while pigface and *Frankenia serpillifolia* occur locally.

The next phase may be occupation by bluebush, but owing probably to the high percentage of salt in many places this is not of general occurrence, and usually appears towards the margins of the tableland, where it merges into sandhills, or where it passes into loamy or sandy flats, *e.g.*, near the edge of the tableland near Arcoona homestead, where most of the species of *Kochia* occur where the saltbush has been eaten away. *K. sedifolia* and *K. pyramidata* are also common amongst, or taking the place of, saltbush towards the southern end of the plateau where the country is bare and eaten out and the gibbers sparse and scattered between Port Augusta and Carriewerloo and the east end of Yudnapinna. Probably the soil is less salty here and thus favours bluebush rather than samphire, while the absence of a gibber mulch would make conditions more xerophytic, so that bluebush rather than saltbush could survive best after drought. This is rather like the saltbush association on the rubble flats described by Collins (5). Saltbush is undoubtedly the dominant plant of the climax association on the tableland and, if left alone, will eventually re-establish itself.

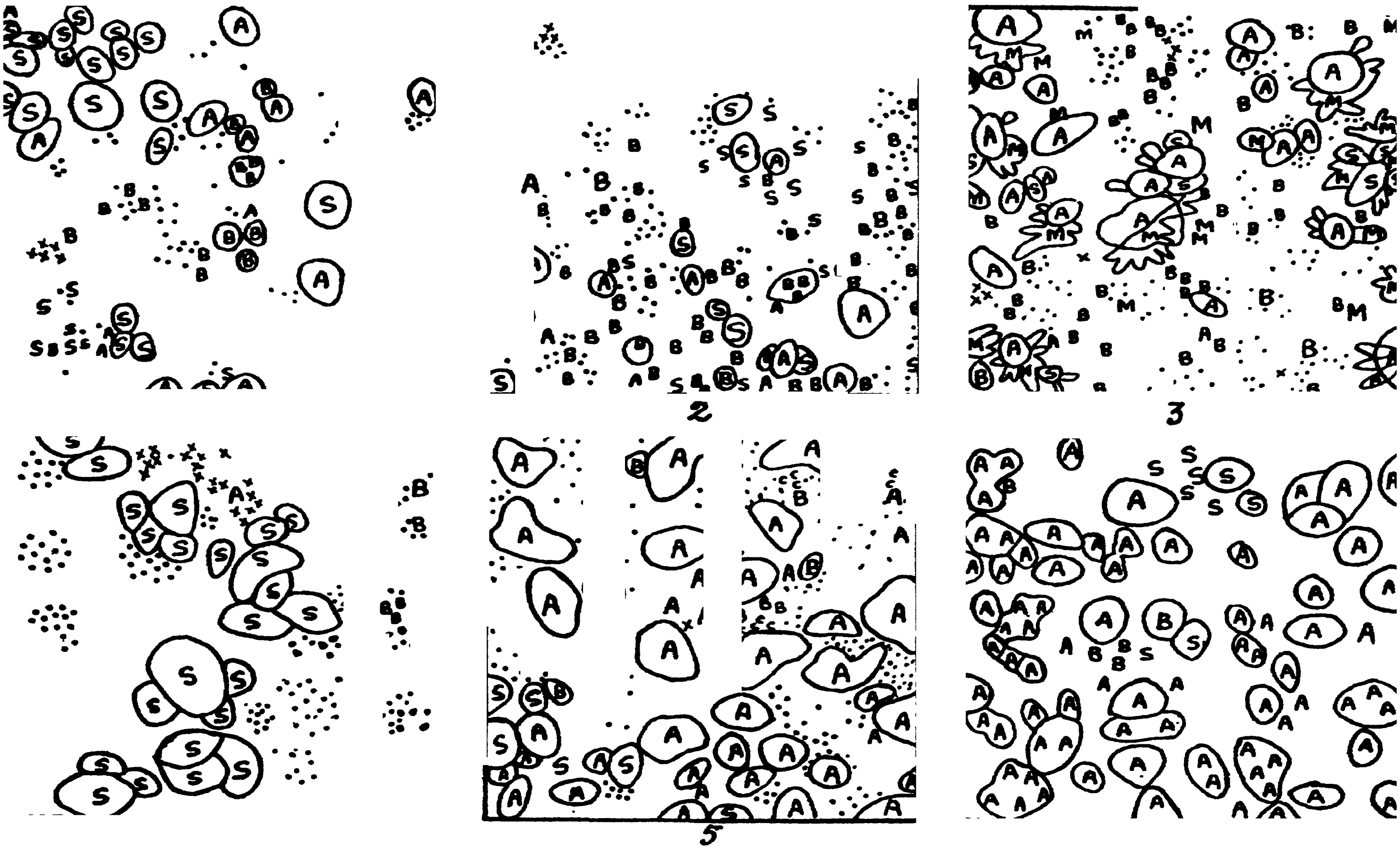
Where the typical saltbush association occurs on loamy or sandy flats on the plateau or outside its limits, as near Whittita or on the more southern stations, it is probably a sub-climax or sere in the myall or mulga scrub associations, in which it usually forms the lower stratum.

During the winter of 1927 a series of quadrats were plotted in the paddocks round the woolshed at Yeltacowie, to show the effects of drought and overstocking in the saltbush association and the development of the subsere following on its destruction. In July rain fell, after eleven months drought, freshened up the saltbush and induced a crop of seedlings and annuals to spring up later. Shearing took place in the early spring, so that for several months these paddocks had not been used much for grazing. Fig. 1 (Nos. 1-6) shows selected quadrats, each 5 metres square, taken in three adjacent paddocks.

The woolshed paddock was surrounded by gibbers, bare except for a little bindyi, and then samphire; towards the middle of the paddock there was little saltbush left, samphire was frequent, and bindyi seedlings plentiful after the rain. (Nos. 1 and 2 were 150 yards apart on either side of a road through the centre of this paddock.) Some bluebush was found in the middle of this paddock; while towards the *Acacia rigens* creek boundary there was some pigface mixed with an increase of saltbush. (No. 3 was 200 yards from No. 2, and 100 yards from creek.)

No. 4 was taken 100 yards from the other side of this creek and in the second paddock, which was not so depleted as the woolshed paddock, but showed a fairly high percentage of samphire, which was replaced towards the centre and other side by saltbush. (No. 5 was 350 yards from No. 4.) There were numbers of seedlings but no pigface or bluebush.

For comparison No. 6 was plotted in the third paddock, about 500 yards from the fence dividing it from the second paddock. Here the saltbush was typically and uniformly good, mixed with a very little samphire. There were numerous saltbush seedlings, but few other plants or seedlings.



EXPLANATION OF FIGURE (quadrats each 5 m. square).

A = saltbush (*Atriplex vesicarium*)
M = pigface (*Mesembryanthemum aequilaterale*)
S = samphire (*Arthrocnemum leiostachyum*)
.... = other seedlings, chiefly bindyi and grasses
B = bindyi (*Bassia* spp.)
xxx = saltbush seedlings
ccc = composite seedlings

(c) *Vegetation of the Creeks of the Tableland.*

There are a number of other plants occurring only in crab-holes or dongas, along the banks and in beds of creeks on the tableland and down gullies in its rocky sides. Thirty-five per cent. of the species collected on the tableland were either confined to the creek beds, etc., or, if also found on the tableland, were most common in the former localities; this refers very noticeably to the larger shrubs and trees, 71% of which were mainly confined to the creek beds; while 30% of the nanophanaerophytes, chaemophytes hemicryptophytes and theophytes were most common in such places.

The only trees at all frequently found on the open tableland were *Eremophila glabra* ("tar-bush"), *Acacia tetragonophylla* ("dead finish") and *Casuarina lepidophloia* ("black oak"). The latter may occur isolated on the tableland, or more often in societies or clans dependent upon its method of reproduction by adventitious root buds. It is more often found in depressions or up steep sides and gullies, where water relations are slightly better than upon the open tableland; and it also frequently lines the creek beds, either in clans or societies, mixed with various acacias and other shrubs such as "nigger-bush," *Rhagodia spinescens, Prostanthera striatifolia, Eremophila* spp., etc.

On South Gap, Pernatty, and Yeltacowie stations, a feature of the landscape is the number of small creeks outlined by the tableland "myall," *Acacia rigens*, which is quite distinct from the myall of the flats *(A. Sowdenii)*. Water only flows in these creeks after heavy rains. The "grey mistletoe" *(Loranthus quandang)* is a common parasite on *A. rigens*. Other shrubs often found along these creeks are:—*A. tetragonophylla, Cassia Sturtii, C. phyllodinea, Heterodendron oleifolium, Exocarpus aphylla, Eremophila glabra* and others, *Kochia aphylla, K. pyramidata* ("nigger-bush"), *Zygophyllum fruticulosum, Abutilon leucopetalum, Sida petrophila, Solanum ellipticum, Dodonaea lobulata, Pittosporum phillyreoides, Muehlenbeckia Cunninghamii*, the "paddy" and "bastard melons" *(Cucumis myriocarpus* and *Citrullus vulgaris)*, and many others. Other creeks are dominated by different small trees such as *Acacia Victoriae*, associated with *Santalum lanceolatum, Eucarya acuminata, Eremophila longifolia*, and other shrubs.

The larger creeks, such as the Elizabeth, Pernatty, Whittita, and Yeltacowie creeks are bordered by *Eucalyptus rostrata* ("red gum"), the only common large tree on the plateau, and remarkably drought resistant. After the breaking up of the last long drought, gum trees, which had been apparently dead for six years, revived at South Gap. In good seasons these creeks often retain water in more or less permanent water-holes at many places. In and along the gum creeks are sometimes found *A. rigens* and most of the small shrubs and trees found along the myall creeks, as well as many others such as:—*Acacia Oswaldii, Myoporum montanum, Eremophila Latrobei, Pimelea microcephala* (rare), *Solanum petrophilum, Trichodesma zelanicum, Phyllanthus lacunarius, Euphorbia eremophila* (typical form), *E. Drummondii, Tribulus terrestris, Hermannia Gilesii*, and numerous grasses and therophytes. *Acacia salicina* ("native willow"), supposed to indicate fresh water occurs rarely.

Small depressions in the tableland, where a greater depth of soil accumulates and moisture collects, may harbour a more varied flora than on the main tableland; they vary in size from crab-holes, chiefly populated by annuals and grasses, to small dongas, when such shrubs as *Eremophila glabra, E. Duttonii, E. oppositifolia, Pittosporum phillyreoides, Cassia Sturtii, A. tetragonophylla, K. aphylla, K. pyramidata* may occur in them. These small communities represent a post-climax induced by the slightly better edaphic and climatic conditions in small local areas than pertain on the open tableland, where the climax is reached in the salt-bush steppe.

(2) Vegetation of the Sandhills.

This differs markedly from that of the tableland; there is not so great a variety of species, but although no large trees are to be found there is an increase of small trees and shrubs. Micro- and nanopanaerophytes form 42·5% of the flora; 9% are chaemophytes; therophytes (31%) and hemicryptophytes (12%) are only to be found after a rainy season.

(a) Colonization of the Psammosere.

There is a marked transition belt or ecotone between the vegetation of the tableland and that of the sandhills. This may be seen behind the homestead at Yeltacowie, as the margin of the tableland is approached saltbush and samphire are replaced by bluebush *(Kochia sedifolia)*, which is superseded by *K. pyramidata* ("pyramid bluebush" or "nigger-bush") as it becomes more sandy; while on the slopes of the more established sandhills mulga *(Acacia aneura* and *A. brachystachya)* are associated with the bluebush.

Sandhills throughout the district vary from bare drifting sand, through various stages of colonization, to the more or less stabilized dunes covered with the stable but open association of the mulga scrub. Where the sandhills are exposed, bare and unstable, the "rattle-pod" *(Crotalaria dissitiflora)* forms pure colonies of considerable size; colonies are also found among the sparsely scattered mulga, when that is able to establish itself. "Roly-poly" or "buckbush" *(Salsola Kali* and *S. Kali*, var. *strobilifera)* also forms pure colonies on the bare sides or in depressions in the sandhills, and surrounding rattle-pod colonies, mulga *Acacia ligulata* ("umbrella bush") and other shrubs; even the dead buckbushes help to stabilize the sand in a dry season.

Then may follow socies of *A. ligulata, Dodonaea attenuata* ("hop"). *Heterodendron oleifolium* ("bullock bush") forms small colonies on drifting sand, and occasionally *Hakea leucoptera* ("needle-bush") is found. *Lycium australe* ("the Australian boxthorn") may also be found as isolated bushes or in small colonies, often at the transition zone between sandhills and tableland or flats; and *Spinifex paradoxus* ("sandhill cane-grass") occurs in similar places. Then the mulga and bluebush become increasingly frequent, and gradually with the aid of smaller shrubs and annuals a more or less stable dune is built up.

Collins (5) described stages in the colonization of sandhills and mulga scrub association on the rocky hills and slopes of the Barrier Region, New South Wales, which have many features in common with the colonization of the sandhills and mulga scrub association developed in this region.

(b) Mulga Scrub Association.

The "Character plant" of the climax association on the sandhills is the mulga (chiefly *A. aneura)*. Besides the shrubs already mentioned others occurring more or less throughout the mulga scrub are:—*Cassia Sturtii, C. eremophila*, var. *platypoda, Myoporum deserti, Eremophila Latrobei, E. Duttonii,* and *E. glabra. Eucarya Murrayana* ("bitter peach"), *E. spicata* ("commercial sandalwood"), and *Exocarpus aphylla* are usually found growing near a mulga, all being root parasites. The last shrub greatly resembles *Templetonia egena* ("broom bush"), which may also be found on the sandhills.

Another common and interesting shrub is *Pimelea microcephala,* which is usually found in a green, flourishing condition with its main stem leaning against or twisted round some other tree, usually a mulga or umbrella bush; in many cases the supporting trees, though apparently more xerophytic than the *Pimelea,* were dying or dead. Either the latter is extremely hardy and deep-rooted or the possibility of root-parasitism presents itself.

The most common undershrub in the mulga scrub association is the bluebush, chiefly *K. pyramidata,* but also *K. sedifolia* on the more stable slopes, and occasionally *K. aphylla.* Various species of saltbush occur on the well-colonized hills, including *Atriplex vesicarium, A. stipitatum* ("sandhill saltbush" which is not liked by sheep), *A. velutinellum* and *A. limbatum;* also several species of bindyi, including *Bassia ventricosa* and *B. parallelicuspis. Rhagodia Gaudichaudiana, Encylaena tomentosa* ("ruby saltbush") and *Gumniopsis quadrifida* ("starbush") are fairly common, often forming tufts on small hillocks of sand. *Glycine sericea* is often found trailing over rattle-pods, and *Trichodesma zelanicum* occurs round bullock-bush and in "blow-outs."

Although it at first appears that bluebush *(Kochia,* spp.) is dominant in the lower shrubby stratum, it is more probable that this represents a sub-climax, and the true climax is attained when the dune is sufficiently stabilized to permit the establishment of the saltbush, which may frequently be mixed with bluebush or, if undisturbed, gradually displaces it. However, here, as in other habitats, the bluebush appears to be more xerophytic than saltbush and to feel the effects of drought less.

The lowest stratum or ground vegetation of the mulga scrub association is largely dependent on the season in which rain falls, as it consists mainly of annuals (therophytes) and grasses. During June and July, 1927, after a long period of drought, there was little therophytic ground covering among the shrubs and trees on the sandhills at Yeltacowie with the exception of buckbush, annual saltbush and some grasses. Rain fell during July and raised up an appreciable growth of seedlings; but the main annual flora developed by these rains was studied at Arcoona in September. The sandhills on this station are covered with mulga scrub similar to that on Yeltacowie and Pernatty, but are, on the whole, more stable and consolidated. The ground stratum, consisting largely of therophytes, was well developed by September.

Emex australis ("Prickly Jack"), *Goodenia cycloptera* and *Phyllanthus Fuernrohrii* being among the first colonizers of the bare sandy hillsides (psammosere). These formed pure colonies or were associated with each other, and were also frequent on the more consolidated parts under mulga and other shrubs, where they were mixed with a varied flora. Seasonal aspects are very noticeable among these lower stratum societies, the following species dominating in turn:—annual saltbush *(A. velutinellum, A. limbatum, A. spongiosum); Podolepis capillaris* and *Blennodia canescens* ("wild stock"); *Zygophyllum Howittii, Z. tesquorum, Z. ammophilum; Swainsona phacoides* ("wild violet"); *Erodium cygnorum* ("blue geranium"—an excellent fodder plant common with the last species on the flats); composites such as *Calotis cymbycantha, Helipterum floribundum, H. moschatum, Helichrysum semifertile, H. apiculatum, Myriocephalus Stuartii, Craspedia pleiocephala, Senecio brachyglossus,* and occasionally *S. lautis; Sidacorrugata, S. intricata, S. virgata,* and *Abutilon leucopetalum; Stipa nitida, Trisetum pumilum,* and other grasses. Other species commonly occurring are *Tetragonia expansa* ("wild spinach") and *T. eremaea, Trichinium alpecurioideum, Lappula concava, Nicotiana suaevolens, Plantago varia,* and *Goodenia argentea,* though that is more common on the flats, and *G. cycloptera* on the sandy parts. Parakeelya *(Calandrina remota* and *C. volubilis),* a splendid fodder plant on which sheep can thrive for months without water, forms prominent societies round the mulgas in a good season; although not as common as on the sandhills, parakeelya is also found on the flats, particularly round the bases of trees.

In April, 1930, there was little ground covering on the sandhills on South Gap, Pernatty, and Oakden Hills. After a prolonged drought rain fell in the preceding December–January, and was productive chiefly of grasses such as *Aristida arenaria* ("mulga grass"), *Triraphis mollis, Paspalidium jubiflorum,*

P. gracile, Digitaria Brownii, Panicum decompositum, etc. *Trichinium alpecurioideum* was also found.

From the mixed mulga scrub described one must distinguish the type with *A. aneura* and *A. Burkittii* ("sandhill mulga" or "needle-bush acacia") dominant. This is common between Yeltacowie and Oakden Hills, along the East-West Railway Line between Bookaloo and Hesso, and on the sand-ridges that intersect the flats just outside the limits of the plateau. Under the spreading *A. Burkittii* there can be little or no undergrowth, but in between the bushes and the other mulgas may be found saltbush or bluebush and the usual annuals in season. *A. Burkittii* may also occur as isolated shrubs in the mixed mulga scrub association.

Quite another type of vegetation is sometimes met with in the sandhill country; mulga scrub on the flats and slopes will graduallly merge into "native pine" forest *(Callitris glauca)*. On the fringe pine and mulga will be mixed, but on the ridges almost pure pine association will occur. Under the pines is little or no undergrowth, except grasses. These pine forests were once much more extensive than they are now, but they have been largely cut down; they may be seen at The Pines on Arcoona, and between Yeltacowie and Pernatty. Occasionally isolated pines or small groups may be found in the mulga scrub association, or more rarely on the flats.

On Arcoona, and elsewhere, one occasionally meets with white sandhills or ridges. The poor salty nature of this white sand is indicated by *Melaleuca pauperifolia* ("tea-tree"), the main tree growing on it. (This is also found on the edge of salt creeks on the tableland.) There is little or no undergrowth, though *Enchylaena tomentosa, Rhagodia nutans,* and *Zygophyllum ammophilum* were not uncommon with "pop-saltbush," "nigger-bush," *Myriocephalus Stuartii, Swainsona phacoides,* and *Emex australia* among the more sparsely scattered trees.

(3.) Vegetation of the Flats.

Flats of varying extent are found between the sandhills on the plateau, as near Yeltacowie and Arcoona homesteads; also covering large tracts of the surrounding country (Recent to Pleistocene), which is sometimes more or less undulating and interspersed with sand-ridges as is much of the country round Island Lagoon and on Oakden Hills and Yudnapinna stations. The soil varies from being sandy or a light red sandy loam to firm, fine clay particles almost merging into a claypan. Though the vegetation of the sandy loam flats has features in common with that of the sandhills and there are transitional stages between the two, the general aspect differs greatly. There is a greater variety and abundance of species, particularly on the well-colonized flats than on the sandhills, but the proportions of the life-forms are similar; small shrubs and trees (37·5%) are dominant on the flats, while there are also 11·5% chaemophytes, 31% therophytes and 14·5% hemicryptophytes.

(a) Myall Association on the Loam Flats.

The dominant or character tree throughout large areas of the flats is the myall *(Acacia Sowdenii)*, which is extremely drought-resistant, more so than even the mulga, but unlike the latter is of little use as a fodder plant. On the hot bare plains its dense needle-like foliage provides a welcome if not very dense shade, and so must have an influence on the growth of shrubs and ground vegetation. Several species such as *Encylaena tomentosa, Rhagodia Gaudichaudiana,* and the parasitic *Exocarpus aphylla* are usually found growing round the bases of myall trees.

The dominant species in the shrub stratum is usually the bluebush. *Kochia sedifolia* and *K. pyramidata* may be associated with each other or form separate

consociations, *K. sedifolia* is perhaps more common in the climax and sub-climax associations, where it may be associated with or replaced by the saltbush *Atriplex vesicarium* and *A. stipitatum*. *K. pyramidata* is more frequent on sandy patches and slopes, round the edge of claypans and in subseres where the vegetation has been disturbed by fire, drought or over-stocking.

The other common shrubs found in the myall association of the loam flats are:—*Myoporum deserti, Eremophila Paisleyi, E. Duttonii, E. longifolia, E. oppositifolia, E. maculata, E. Latrobei, Dodonaea lobulata, Pittosporum phillyreoides, Cassia eremophila* var. *platypoda, Eucarya acuminata,* and *E. spicata. Heterodendron oleifolium, Templetonia egena* ("broom bush," used for thatching), *Eremophila glabra* and *Cassia Sturtii* ("blood bush") occur frequently, either as single species in the myall association or as dominant species of societies which may exclude the association dominant. Several distinct strains of *C. Sturtii* were found on the flats.

Myoporum platycarpum, so-called "sandalwood" by bushmen, often a fairly large tree from 5-10 metres high, occurs frequently on the larger more established flats where the soil is deeper; while mulga and *A. Burkittii* appear on sandy patches and on the rises.

The ground vegetation and succession of aspect societies after winter and spring rains resemble those of the sandhills; some species prefer one habitat to the other, *Podolepis capillaris,* wild violet, geranium, and some grasses being more common on the myall flats. *Helipterum polygalifolium, Senecio Gregorii, Zygophyllum prismatothecum, Z. fruticulosum, Pappophorum avenaceum,* and *P. nigricans* are found on the flats, while *H. floribundum, Helichrysum apiculatum, Z. tesquorum, Z. apiculatum,* and *Senecio lautis* prefer the sandhills. On the mulga flats spinach and *Myriocephalus Stuartii* are most common. *Bassia obliquicuspis, Stipa nitida,* and other grasses came after summer rains, while in winter, after a drought, there was little on the bare ground but *Salsola Kali, Babbagia,* and bindyi.

(b) Colonization and Succession on the Flats.

Claypans may represent the prisere stage in the colonizations of the flats, but for the most part they are quite devoid of vegetation (the larger ones being bare, except for occasional colonies of *Nicotiana glauca* and *Spinifex parodoxus,* which form large tussocks on mounds of sand). In others, where water sometimes lies, *Kochia brevifolia* is the first colonizer of the hard-baked, cracking clay; this is also found near salinas. Then follow *Babbagia,* samphire on mounds, with some scattered saltbush, surrounded by bluebush, starbush, bindyi, and *Rhagodia.*

The smaller flats among the sandhills on Yeltacowie and Arcoona were colonized by bluebush, *Babbagia,* bindyi, samphire (round the edges usually), buckbush, and *Crinum pedunculatum* ("36-hour or Murray lilies"). *Kochia sedifolia* becomes dominant with *K. pyramidata,* which may replace it on the slopes, sand patches or at the edge of a claypan, where *Phyllanthus Fuernrohrii* also occurs.

As the soil develops *K. aphylla* ("cotton-bush"), star-bush, hop, *Acacia ligulata* and, occasionally, boxthorn come in, particularly round the edges. For the most part these are the only plants, but grasses such as *Stipa nitida* and annuals occur in season. Pure bluebush flats are not uncommon, but occasionally *K. Georgei* may be mixed with the *K. sedifolia,* especially where the loam is deeper.

Then the myall establishes itself and a typical myall-bluebush *(K. sedifolia-K. pyramidata)* associes develops. At first there are perhaps just those three species, with the annual ground covering in season, then come in the shrubs and undershrubs already described for this association. As the soil becomes more loamy and deeper mulga and saltbush appear, until patches of pure mulga-saltbush

may result, particularly on the sandy parts, for in this region mulga is nearly always an indicator of sand (pl. iv., fig. 2).

On most parts of Arcoona and Yeltacowie an association built up of these two consociations represents the climax, whether it be an edaphic climax due to the limited size of the flats or a climatic climax limited by the slightly lower rainfall which excludes the frequent occurrence of *Myoporum platycarpum*. This tree is very infrequent on the plateau, occurring very rarely below the 6-inch isohyet, is scarce and scattered between that and the 7-inch isohyet, while between the 7- and 8-inch isohyets, as on the extensive flats outside the plateau, on Carriewerloo, Yudnapinna, and parts of Oakden Hills it is very common, mixed with the myall, and in some places being the dominant species in abundance as well as size (pl. iv., fig. 3). Towards the southern and western boundaries of these stations one crosses the 8-inch isohyet, and immediately mallee is found, at first mingling with the myall, mulga, and *M. platycarpum*, then gradually replacing them as more typical mallee scrub is developed. Thus *M. platycarpum* may be an indicator of slight rainfall variation between the 6–8-inch isohyets. It also appears to need a certain depth of soil and a sandy mulch.

Under normal conditions it would thus seem that the myall-bluebush association is a sub-climax on the rather hard, bare clay or loamy flats, and the mulga-saltbush association a sub-climax on the more sandy parts. Only on the larger loamy flats, where the soil is deeper, can the true climax association develop, with myall trees of considerable size as the most frequent tree, but with tall *M. platycarpum* giving height and character to the scrub, and with mulga also frequent, either mixed with the myall or forming locally dominant consociations on the sandy parts. In this climax association saltbush, where not killed by drought or eaten out by stock, is dominant in the lower stratum, though *K. sedifolia* is also frequent and may take the place of the saltbush should the stability of the latter species be disturbed. *K. pyramidata* is the most hardy of the three and will thrive where little else will grow, and will choke out the other two species provided that adverse conditions give it a chance to establish itself.

(c) *Regeneration.*

After the exceptionally heavy rains of 1920-1921 there was such an abundance of grasses and annuals on the flats that when, in the following year, a bush-fire started in the dry feed it spread throughout the district, destroying much of the myall-mulga *(M. platycarpum)* scrub on parts of Oakden Hills, Yudnapinna, and Carriewerloo stations. As the annual rainfall gradually fell during the following years, to culminate in the drought of 1928-1930, regeneration has necessarily been retarded—if, indeed, complete regeneration be possible on bad patches that are already deteriorating with drifting sands. When viewed in March, 1930, after the summer rains, this burnt country was still very barren; the "nigger-bush" *(K. pyramidata)* being the only shrub which had survived to any extent; this plant is remarkably hardy, and also thrives on country which has been "eaten-out" or drought-stricken. The common bluebush *(K. sedifolia)* was also found, but less frequently. The bullock-bush *(Heterodendron oleifolium)*, another extremely hardy shrub or small tree, often survived, either in isolated cases, or more often in small colonies which were spreading. In many cases these shrubs were sprouting again and growing quite vigorously, after having, apparently, been dead for some time.

This scrub, like saltbush and "nigger-bush," may actually benefit from judicious pruning; mulga, *Cassia* and *M. platycarpum* will also stand a considerable amount; while other shrubs that are too harshly cut may never recover. Thus, where scrub-cutting is necessary, as in a bad drought, it is advisable that it should be done with restraint and discrimination, having due regard to the recuperative powers of the

various shrubs; it will often not be found practical to keep a few hundreds of sheep alive at the cost of destroying the natural fodder resources of the country for all time.

Stipa nitida was the most common grass on the burnt flats at this time, most of it having dried off by March; while *Bassia paradoxa* was another colonist of this burnt subsere. Miles of dead bushes of myall, bluebush, mulga, and saltbush were all that remained of good scrub country. Here and there a myall or two had escaped, but for the most part the plains were bare, except of scattered "nigger-bush," odd sprouting bluebush, colonies of bullock-bush, and very occasionally *Templetonia egena;* with, at times, *Lycium australe* in small patches where water had collected.

(4) SALINAS AND FRESH-WATER SWAMPS.

The saltmarsh association around the salinas and salt-lakes that are so numerous west of Lake Torrens resembles that found in similar places near the sea-coast and in similar places inland. Samphires are the dominant species. *Arthrocnemum halocnemoides*, var. *pergranulatum*, was found round the edge of Lake Torrens, near Sandy Point, while *Kochia tomentosa*, var. *appressa*, was growing in sand a few feet from the damp surface of the lake, with starbush and saltbush slightly higher up the banks.

The three most common types of fresh-water swamp associations were dominated, respectively, by "cane-grass" *(Glyceria ramigera)*, "cotton-bush" *(K. aphylla)* and *"lignum" (Muehlenbeckia Cunninghamii)*. In them a varied ground vegetation is often developed, including samphire, nardoo *(Marsilea Drummondii)* and *Cressa cretica*.

VI. VEGETATION MAP OF THE LAKE TORRENS PLATEAU.

In Prescott's Vegetation Map of South Australia (20) the whole region dealt with in this paper is marked as dominated by mulga and its allies, and also as lying within the limits of distribution of saltbush, bluebush and cotton-bush. Generally speaking this is correct, as such mulga associations have been shown to represent the climatic climax of the district. However, owing to edaphic limitations, the greater part of the Lake Torrens plateau can never support mulga scrub or mulga and myall consociations; the "gibber tableland" consists almost entirely of saltbush steppes, with an almost complete absence of trees, except in the creek-beds.

On page 90 is reproduced a vegetation map of the Lake Torrens plateau and its surroundings which gives the distribution of the three main associations dealt with in this paper, *i.e.*, saltbush on the gibber tableland and stony hills, myall on the flats, and mulga on the sandhills. In the case of the last two, it must be remembered that small flats with myall occur between the extensive sandhills, while the more definitely loam-flat country is often more or less undulating and intersected by sand-ridges with mulga.

The geological outlines of the plateau and its outliers are taken from Ward's Geological Map of South Australia (24), where they are marked as "Ordovician?" The distribution of the vegetation is based on the author's own observations and, also, especially in the part not described in this paper, from detailed survey plans kindly lent by the Surveyor-General, Mr. J. H. McNamara, and his predecessor, Mr. T. E. Day.

VII. SUMMARY.

The Lake Torrens plateau lies to the west of Lake Torrens, and consists of flat-topped hills and stony or gibber tablelands with patches of sandhills and clay or loam flats. It is surrounded by extensive loam plains intersected by sand-ridges, salt-water lagoons and fresh-water swamps. The part described in this

paper extends to Island Lagoon. The whole area lies between the 5- and 8-inch isohyets, and is part of Tate's Eremian Region.

Out of a total of 387 species, of which 31 are endemics and a small percentage of Northern or Central Australian origin, the flora is composed largely of migrants, almost equally divided between the Eastern and Western centres of distribution, as is the case also in the Gulf Region of this State, although the actual composition of the two floras is very different, only 43 being shared, the Lake Torrens Region having more in common with the drier parts of West Australia, New South Wales, and Northern Victoria.

Most of the species found are fairly widely distributed throughout South Australia, only seven being endemics confined to the plateau; most (81%) are shared with the Far North of this State, while 44% are found on the adjacent Flinders Range. Other floristical statistics are given.

The various geographic, climatic and edaphic factors influencing the ecology of the vegetation are described; an analysis of the life-forms is given in the spectra of the region and various habitats; and several compound species such as *Atriplex vesicarium* are discussed.

It would appear that the climatic climax for the whole region is an open scrub formation of the myall-mulga-*Myoporum platycarpum* type, with a saltbush-bluebush lower stratum among the various societies of larger shrubs that grow among the three main dominants. This climax can only be attained when optimum soil conditions prevail, *i.e.*, a certain depth of soil with a sufficient sandy mulch, such as is chiefly found on the plains surrounding the plateau; it may also be somewhat influenced by the rainfall. Hence different edaphic or sub-climaxes are developed on the three main habitats:—saltbush steppes on the gibber tableland; mulga scrub with bluebush or saltbush, according to the state of consolidation, on the sandhills; and myall-bluebush association on the hard loam flats with fine particles and firm clay soils, with mulga-saltbush on the sandy flats. These associations are described in detail with notes on succession, regeneration, etc.

The most interesting feature of the district is the widespread occurrence of samphire (chiefly *Arthrocnemum leiostachyum* and *Pachycornia tenuis)*, which were not only found round the swampy areas but were of frequent occurrence and widespread distribution on the rather saline soils of the tableland and flat-topped hills, associated with the saltbush.

A vegetation map of the district is given. No authority is given for the specific names, but the nomenclature throughout is that given by Black.

ACKNOWLEDGMENTS.

The author wishes to thank Mr. and Mrs. G. P. Blackmore, late of Yeltacowie, whose hospitality made this paper possible in the first instance; also the Trustees of the Commonwealth Science and Industry Endowment Fund, for a grant which enabled her to complete it; and Mr. J. M. Black, for identifying and checking many of the more difficult specimens. She is also indebted to Mr. and Mrs. C. Martin, late of Arcoona, and the managers of other stations visited; to Mr. J. G. Wood, of the Botany Department of the University of Adelaide, for his helpful advice, loan of apparatus, etc., and to Messrs. Tom Kidman and A. Wellby, of Oakden Hills, for specimens.

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DESCRIPTION OF PLATE IV.

Fig. 1. Gibber tableland, South Gap, showing samphire *(Arthrocnemum leiostachyum)* with a little saltbush *(Atriplex vesicarium)* in right foreground.

Fig. 2. General view of myall *(Acacia Sowdenii)* and bluebush *(Kochia sedifolia)* flat between sandhills, Arcoona. Mulga *(A. aneura)* colony at left and on distant sandhills. *Salsola Kali and K. pyramidata* on slope in foreground.

Fig. 3. Loam flat near Bookaloo. Tall trees are *Myoporum platycarpum* with myall in the background; ground covering chiefly *A. vesicarium* mixed with *A. stipitatum* and *K. sedifolia; Eucarya spicata* (commercial sandalwood) is the dark shrub in centre, left of tallest tree.

THE DEAD RIVERS OF SOUTH AUSTRALIA.

PART I. THE WESTERN GROUP.

By PROFESSOR WALTER HOWCHIN, F.G.S.

[Read September 10, 1931.]

PLATE V.

CONTENTS. Page

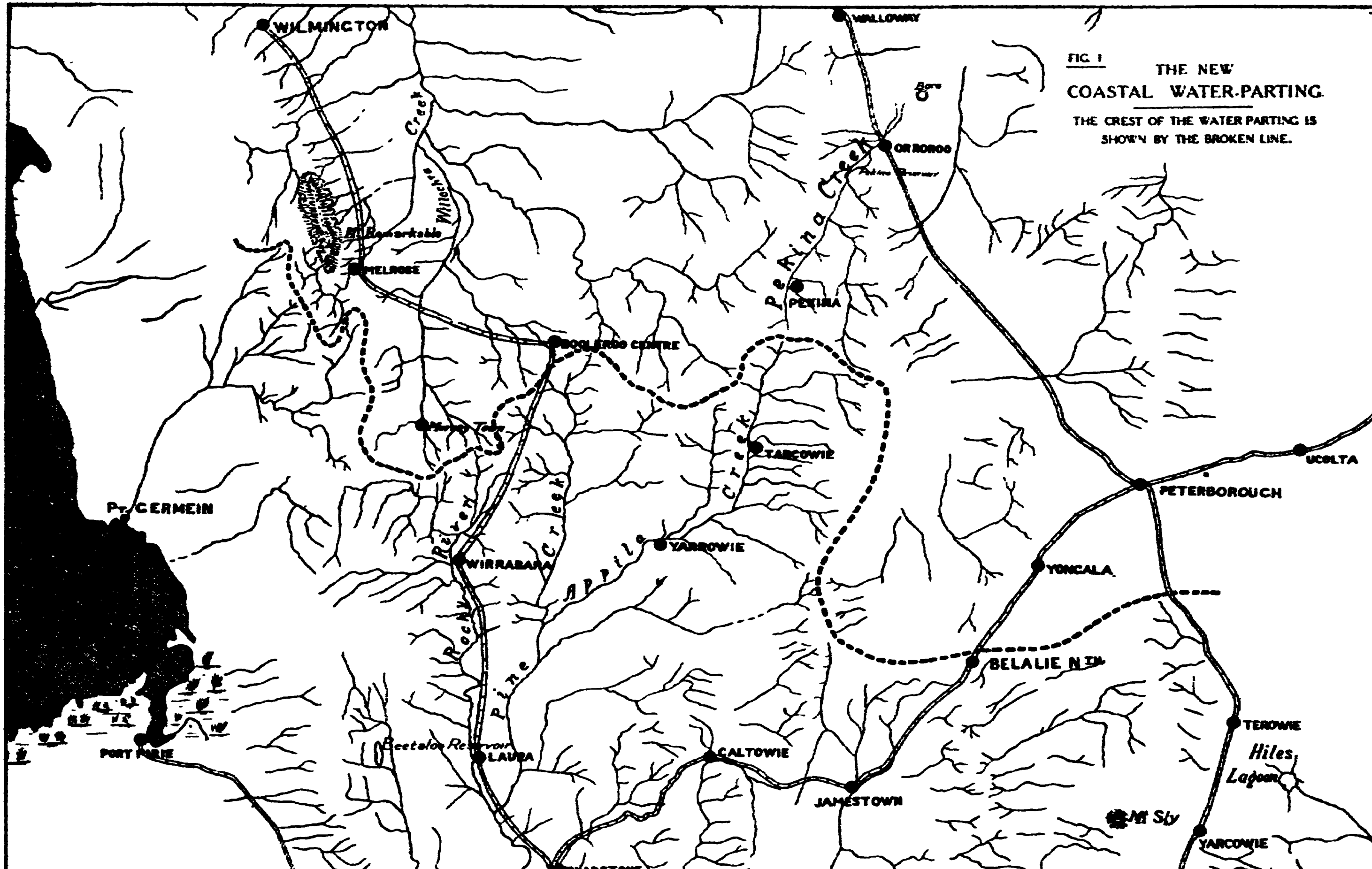

Fig. 1. Map of the crest of the New Coastal Water-parting. Illustrates the plateau-like summit and the fragmentary nature of the existing drainage system.

FOREWORD.

At the Melbourne meeting of the Australasian Association for the Advancement of Science, held in 1913, the present writer gave a Presidential Address before Section "C" on "The Evolution of the Physiographical Features of South Australia." In that address special attention was directed to the revolutionary geological changes that occurred in Central and South-Central portions of Australia during the Pleistocene Period. In these earth movements a new coastal watershed was developed, with a correlative sag to the northward, which brought the Lake Eyre country below sea-level, and resulted in a general deformation of the hydrographic systems within the region concerned.

The present paper is devoted to a consideration of the same subject in greater detail, including some features of the older continental watershed that is now in a state of decline; the development of a new water-parting, parallel with the coast; and also the delineation, as far as possible, of such ancient river channels, now mostly obsolete, that formed the western portion of the antecedent hydrographic system; leaving to a later paper the consideration of those defunct rivers that formed the eastern portion.

I. A SENESCENT WATERSHED.

There can be little doubt that the MacDonnell Ranges have through long ages formed the main central watershed of the country with a discharge of its waters to the sea at the southern coast, and, possibly, to the north as well. In their present condition they show an extensive Pre-Cambrian massif, reduced to a plateau of only moderate elevation, that originally formed the core and roots of mountain ranges that were of Alpine magnitude. The base of these now greatly-reduced ranges was laved by the waves of the sea in Cambrian times, and, later, by those of the Ordovician; and it is highly probable that the glaciers of the Finke, during the Permo-Carboniferous Period, had their source on the snow-fields of their summits; while, still later, they shared the scene with the palm-margined, fresh water lakes that made a characteristic feature during the Triassic and Jurassic Periods; and finally the sea returned during the Cretaceous Age, filling with its sediments the extensive basin caused by the slowly sinking land of the central region.

The marine and fresh-water sediments that were laid down during the successive geological periods must have been largely obtained from the waste of these ancient highlands reduced now almost to a common level. The general effects produced by such varied conditions of denudation and reconstruction have repeatedly changed the face of Nature throughout this vast region, and there is left the difficult task of disentangling and assigning their proper place to the residual land forms that have followed from such diversified phenomena. Some of the physiographical features date back to remote times, and may be anachronistic in relation to other surface forms with which they are immediately associated.

(1) It is to *the rivers* that we must look to obtain a clue to the events that more immediately preceded the existing order of things. The main lines of relief that prevail throughout these central highlands are remarkably simple and persistent. The strike is almost uniformly east and west. Ridges of rock form lines of outcrop that are continuous for many miles, and these prominent features are separated from each other by intervening valleys or plains, varied sometimes by minor swellings or by sandy flats smoothed over by wind-borne sands carried from the drier regions.

The rivers of the central highlands show some remarkable features. The river channels are commonly at right angles to the ranges, and are of a con-

sequent type. They originated in a former epeirogenic uplift of the region with low grades, in their initial stages, which led in many instances to a very serpentine course. The present features are those of a dissected plateau, with the rivers deeply incising and intersecting the hard ridges, forming numerous narrow gaps that mark the inlets and outlets of the river courses as the streams enter and leave the low intervening valleys.

The characteristic weathering of the region forms a striking illustration of weak atmospheric action incidental to a dry region, while the predominant solar control is seen in the nearly vertical walls of the gorges (rising frequently to several hundreds of feet), dislocated masses, that encumber the river beds, and river erosion, limited to intermittent floods which find their way through water-gaps that are often only a few feet in width. The gorges are as distinctive a feature in the smaller contributory streams as in the main water-ways, forming a region of entrenched meanders. The absence of waterfalls throughout this extensive region of highlands in Central Australia is a remarkable feature.

(2) *The geological history* of this somewhat complex region includes several periods of peneplanation, together with successive geological systems distributed over the Pre-Cambrian, Palaeozoic, Mesozoic, and Tertiary ages, with a central complex of great extent that probably has not been below sea-level from Pre-Cambrian times.

The material that has been removed from these primitive highlands by denudation has reduced their former height by many thousands of feet. That river action (and probably ice action as well) have been energetic agents in the transportation of this material is evidenced by the extensive deposits of alluvial sediments that occur throughout the central regions.

At the present time most of the drainage from the main watershed has a southerly direction. The chief rivers are The Palmer, The Hale, The Todd, The Hugh, and The Finke. The last named ultimately captures the others, forming a main or trunk stream. Some of the rivers, the Finke particularly, follow a very serpentine course, noted by all travellers, compelling the latter to leave the bed of the river, in many places, and for considerable distances travel parallel with the stream but on higher ground. [See Map in "Horn Expedition" and S. A. White's Map, Roy. Soc., S. Aus., xxxviii., 1914, p. 407.]

(3) In the *physiographic features* of the river systems there is a curious combination of mature and juvenile aspects. The reduction of grade in the river courses, absence of waterfalls, and intersection of wide valleys on a common grade with the hills, point to a mature condition; while the deeply-cut and narrow gorges are equally suggestive of a juvenile type. This blending of contrasted physiographic features can be explained by the peculiar climatic conditions under which the facial sculpture has been effected, viz., a limited rainfall and dry atmosphere affording only weak weathering effects, together with occasional floods and powerful stream erosion. The meandering of a great river, like that of The Finke, must have been initiated during a peneplanation stage that had reached a local base-level with low grade, followed by an epeirogenic uplift that led to the deep incisions of the river channels.

A marked feature of Central Australian geology is the enormous development of conglomerates of various ages, monoliths of which are seen in Ayers Rock, Mount Olga, and Mount Currie [Chewings], that indicate important rivers, of strong grades, and with adequate powers of transport. Such a vast and powerful hydrographic system must have had its outlet at the southern coast in former times.

The earth movements that produced the sag and lake basins across the main line of southerly drainage, until its central region sank below sea-level, had the effect of integrating the drainage both on its eastern and western sides. The western affluents of the River Murray were captured on the one side, and those draining from the Musgrave Ranges on the other. If Lake Eyre was brought up to the level of Lake Torrens (a difference of about 100 feet) the Cooper and other affluents that now find their way into the eastern side of Lake Eyre would have to find an outlet further to the east. Prior to the east-west uplift, with its concomitant sag to the north, these streams probably united with the Darling, or took a course through the gap that occurs between Cockburn and Broken Hill and united with the Murray; or, possibly, following a course more to the westward, found an outlet in the direction of Lake Frome. Cockburn is at present nearly 700 feet above sea-level, but this presents no difficulty, as it is included within the limits of the raised area, which has a value much exceeding that height.

II. DEVELOPMENT OF A NEW WATER-PARTING.

It is generally accepted that during the late Pliocene or early Pleistocene periods there was an extensive movement of plateau elevation in southern Australia. In South Australia the uplift took the form of a broad and gentle geanticline parallel to the coast, the summit of which, in a line with the Northern railway, is situated at an average distance of about 150 miles from the seaboard. The limbs of the anticline extend, respectively, from near Adelaide, in the south, to Marree, northward, where the beds dip under the Cretaceous clays of the Lake Eyre basin. The summit of the fold is marked by the dividing of the drainage, in gravitating, either to the northward or the southward. By reference to fig. 1 it will be seen that this water-parting follows a very serpentine course. This outspreading is occasioned by the relative flatness of the summit and the influence of small differences in level in determining the direction of the streams.

If such a deformation has occurred in South Australia within so recent a time, as is believed to have been the case, it must have had a revolutionary effect on the river systems as well as on the climatic conditions of the country. The evidences that support this view may be briefly stated.

(1) *The Geological Structure of the Area.*—The fold takes the form of a simple corrugation (or geanticline), as already stated, in which the strata, rising from sea-level near Adelaide, carry rocks of the same geological horizon (although much faulted and distorted) over a bend, exceeding 2,000 feet in height, to sea-level on the northern side in a distance of 500 miles. [See fig. 2.]

(2) *A Topographical Incongruity,* where a central and ancient continental river system is blocked by a transverse land barrier in its discharge to the ocean, giving rise to an extensive development of inland lakes on the northern side of the barrier and a comparative absence of rivers on the southern.

(3) *The Physiographical Outlines of the Country* show that the main features of physical relief have had an origin antecedent to the present geographical cycle.

(4) *The Discordance of the Existing River Channels* in relation to the main features of the physical relief—the modern rivers often intersecting the antecedent river channels at various angles with a westerly tendency. This westerly direction (as opposed to a southerly one) has been caused by the great meridional fault of South Australia by which the country has received a tilt to the westward.

(5) *The Relatively Juvenile Stage of the Existing Rivers* in their erosive effects.

(6) *Blind River Channels*, now mostly dry, that occur on the raised barrier and that have no definite relation to the existing drainage.

(7) *Deep Alluvial Deposits* occupy these deserted river beds and, by absorption of the local drainage cause short stream-lengths, as laterals, that have an intermittent existence.

(8) *Secondary Silicification* often occurs in the older river deposits by which the silt, sands, and gravels are converted into extremely hard rocks that simulate rocks of much greater age and are often broken for road metal or are too tough for this purpose. Mostly situated at high levels.

(9) *Evidences of Far Transport of Material.*—When the sediments have been preserved in their original loose condition the pebbles are seen to be very highly water-worn. Some of these, consisting of quartz and as large as cricket balls, are often worn perfectly round, giving evidence of stream attrition having been carried on over long distances. Silicified wood is also not unfrequently found in these ancient gravels.

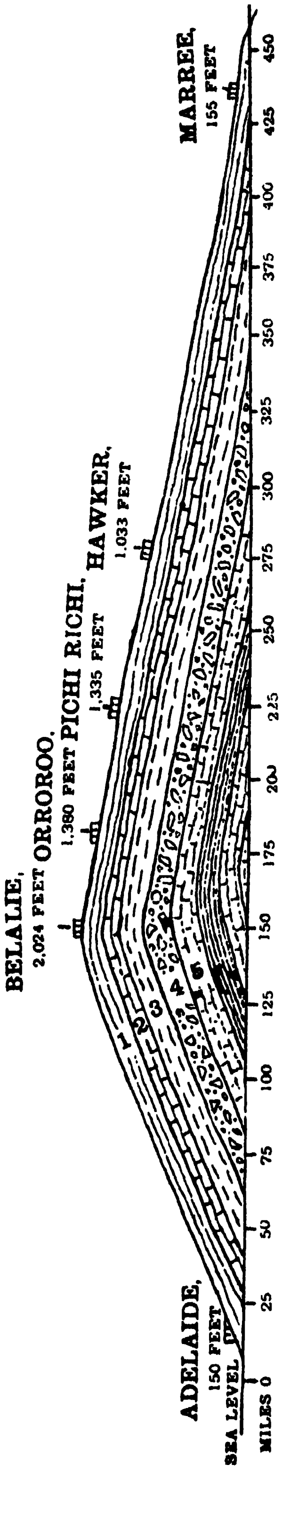

Fig. 2. Diagrammatic Geological Section of the New Coastal Water-parting. *Cambrian:* 1. Purple Slates and Quartzites. *Adelaide Series:* 2. Brighton Limestone. 3. Tapley's Hill Slates. 4. Sturtian Tillite. 5. Mitcham-Glen Osmond Slates and Quartzites.

III. THE BETRUNKED RIVER FINKE.

(1) *Lake Eyre.*—Many rivers converge at the northern end of Lake Eyre, the chief of which are The Diamantina, The Warburton, The Alberga, The Macumba, and The Neales. The Finke, in flood, may mix its waters with those of the Macumba, but is mostly lost by absorption before reaching Lake Eyre. As forming the chief water system of the MacDonnell Ranges it may be taken to represent the trunk river or chief channel of discharge to the Southern Ocean in the preceding geographical cycle of the region.

There is relatively low ground between the southern end of Lake Eyre and Lake Torrens with a slight gradient to the former. In this depression bordered by rises of over 500 feet, Chambers', or Stuart's, Creek flows northward into the southern end of Lake Eyre. In view of the development of the new water-parting we must assume that Chambers' Creek occupies the former channel of The Finke in its southward flow but, by earth movements, has been reversed in its direction. Prof. J. W. Gregory, in writing of Lake Eyre, says: "Its western rim is formed by the eastern slope of the apparently eternal platform of Western Australia. A detached fragment of its floor now lies at the northern end

of Lake Torrens and links the Lake Eyre basin to the Great Valley of South Australia." ["Dead Heart of Aus.," p. 146.]

(2) *Lake Torrens.*—Lake Torrens occurs in a wide plain bordered by the Flinders Ranges on the east and a plateau of moderate elevation on the west. The lake lies in a shallow depression near the highest part of the ridge between Port Augusta and Lake Eyre, a height variously estimated at a little more than 100 feet above sea-level. Port Augusta is about 40 miles distant from the southern end of Lake Torrens, following a down grade of about two and a half inches in the mile, scarcely sufficient to maintain a current, and is marked throughout by a succession of shallow claypans and swamps divided by several recognized "crossings" for traffic. In times of heavy floods Lake Torrens is reported to overflow and carries its fresh water down to the sea, causing the waters at the head of the Gulf to be muddy. Others consider that an overflow of Lake Torrens is improbable, and that the muddiness at Port Augusta is entirely caused by local flood waters. Taking into consideration the physical structure of the country and recent earth movements, with a fairly defined channel of drainage—northward to Lake Eyre and southward to Port Augusta—it seems highly probable that prior to the tectonic movements The Finke followed the direct and depressed channel to the sea, via the present, now elevated, channel of Lake Torrens.

(3) *Period of Great Fluvial Action.*—There are many indications that in the geographical cycle that preceded the present order Central Australia was blessed with a more abundant rainfall and more permanent rivers than exist today. We may assume that these more favourable pluvial conditions synchronized with the existence of the permanent ice-fields that occurred in south-eastern Australia and in Tasmania during the Pleistocene Period, accompanied by a lowering of the mean temperature throughout southern Australia, of which we have some evidence in the retreats to warmer latitudes of some molluscs formerly abundant in South Australian waters. In evidence of the former existence of permanent fresh-water rivers in Central Australia in excess of the present, teeth, scutes, and portions of skulls of crocodiles have been obtained from the eastern side of Lake Eyre as well as at Port Augusta; also teeth of *Neoceratodus* from the Lake Eyre basin. [See Howchin: "Building of Australia and Succession of Life," pp. 659, 661. Government Printer, Adelaide.]

At the time when the rivers of the central region came through to the southern coast the existing seaboard was probably at a higher elevation than at present, and Spencer Gulf was either non-existent or on a much smaller scale. Many of the islands at the entrance to the gulf are covered by dune sand. Wedge Island, one of the Gambier group, has a base of older rocks at about sea-level, on which rests a pyramidal mass of dune sand which, at its south-eastern angle, rises in an almost perpendicular cliff to a height of 660 feet, capped by travertine limestone. It is self-evident that such an accumulation of blown sand could not form on an island 20 miles from land. The inference is that within comparatively recent times Spencer Gulf either had no existence or was greatly narrowed in its limits—possibly to that of a delta of The Finke.

[For remarks on an ancient alluvial deposit at Port Moonta, see forward, Section VI., No. 9.]

IV. THE EXTINCT ARDROSSAN RIVER.

The remains of an important river occur near Ardrossan and for some distance southward, bordering the western side of Gulf St. Vincent. The most northerly position for these remains was noted in Section 77, Hundred of Cunningham. On the southern side of Ardrossan the alluvial beds form a

coastal scarp parallel with the coast and at an average distance of one mile from the latter. The beds which are consolidated and highly siliceous are very massive and strongly exposed. On the northern side of the district road that passes inland from Parara Head Station the beds form three terraces. resting on Cambrian limestone, in a vertical height of 100 feet. and 300 feet above sea-level. In their northern extension they rest on fossiliferous Miocene making a complete local occurrence three miles in length.

Similar consolidated alluvia form Rocky Point, situated 12 miles to the southward of Ardrossan. Rocky Point is 80 feet in height and carries diversified sediments, including petrified wood.

On the southern side of the jetty at Ardrossan are high cliffs that give interesting sections. The basal portion consists of indurated mottled clays of Pleistocene age. The upper surface of these clays shows subaerial erosion with Recent clays resting unconformably on the latter. There is thus in this neighbourhood three distinct sets of beds which are post Miocene and of discordant ages. (1) The high-level siliceous alluvia resting on a Cambrian floor, which is probably of Older Pleistocene age. (2) An indurated mottled clay series of Newer Pleistocene age. (3) And a Recent clay-bed of considerable thickness that occupies eroded valleys in the Newer Pleistocene. [See Howchin: "The Geology of Ardrossan and Neighbourhood," Trans. Roy. Soc. S. Aust., xlii. (1918), pp. 185-255, pls. xix.-xxix.]

The relationship which this now extinct river bore to the other ancient lines of drainage is uncertain, as it is isolated. Only the right bank of the river course has been preserved, the left bank having been submerged by the sea. The inference, based on geographical features, is that the river drained the plain on the western side of the Barunga and Hummocks ranges, and the northern portion of Yorke Peninsula, finally uniting with the trunk stream that flowed down the valley now drowned by the sea.

V. THE ANCIENT NORTHERN FLINDERS AND WILLOCHRA CREEK CHANNEL.

(1) *Western Plain of the Northern Flinders.*—The Flinders Ranges, in both their northern and southern groups, show a very bold scarp, facing westwards. This persistent feature is, without question, a fault-scarp with a downthrow to the westward. This sunk-land, bordering the fault-scarp, has a uniform feature of fluvial and porous sediments. In its northern portions, the plain between Lake Torrens and the Flinders Ranges, has an average width of about 24 miles. In this section The Parachilna, Brachina, Hookina, and other creeks from the Flinders Ranges debouch on the plains and, after continuing for some distance, according to the volume of the flood-water, are finally absorbed and disappear below the surface. Whether these sediments were built up as alluvial fans from the ranges or were laid down by a former north and south river, now extinct, is not quite certain, but are probably the result of both agencies. That such a river, at some time, received the drainage of the eastern ranges, and flowed southward, is highly probable. In support of this view there is a clearly defined valley going south, in which the Willochra Creek, as a reversed stream, after flowing northwards for about 75 miles, takes a sharp right-angled turn to the west, at a distance of 24 miles from Lake Torrens, and falls into this lake.

As the Willochra Creek is the most important stream at the present time occupying the bed of the ancient river, it may be taken as the representative of the extinct trunk line of drainage now under consideration.

(2) *Melrose-Willochra Plain.*—This plain is defined on its western side by the Southern Flinders Ranges, its chief heights being, Mount Brown, near

Quorn, and Mount Remarkable, near Melrose. On its eastern side it is separated from the Orroroo plain by the Eurelia, Pekina, and Narien ranges. The railway line passes over this dividing ridge, at the following heights. At Orroroo, the railway station is 1,380 feet above sea-level; the line reaching its maximum height of 1,733 feet at Eurelia; descending on the other side to 1,510 feet at Carrieton; 1,386 feet at Moochra; 1,036 feet at Hammond; and then reaches the Willochra level at 783 feet at Bruce.

A well was sunk by Mr. G. H. Lehmann, four miles to the westward of Bruce [about half-way between Carrieton and Quorn], particulars of which were kindly supplied to me by his brother, Mr. F. H. Lehmann, as follow:—Clay and boulders, 115 feet; pure clay, 30 feet; white sand, 20 feet; then alternating clay bands and white sand to a depth of 199 feet, when the sinking was stopped without reaching bed-rock.

(3) *Booleroo Plain.*—Twenty-four miles to the southward of Bruce the Booleroo plain carries many evidences of extinct river action. Remains of the older and consolidated alluvia are frequently seen. Those portions of the fluvial sediments that have not undergone silicification have been subjected to denudation, while the silicified portions are, usually, more or less in relief and cover extensive areas.

The Booleroo plain extends into the western portion of the adjoining Pekina Hundred. On. Mr. Brooks' farm [Sec. 253, Hd. Pekina] and other paddocks in the neighbourhood, remains of the older sediments are very common. Travelling westward on the main road between Orroroo and Melrose silicified gravels occur on the southern side of the road a mile to the eastward of Booleroo Centre, also on the northern side of the road about two and a half miles to the westward of the same township. Both coarse and fine material have been cemented, taking the form of more or less spheroidal masses or large sheets of solid stone, which, if examined apart from its surroundings, might be mistaken for geologically-ancient quartzites. The surface of these stones and sheets is usually smooth (sometimes glazed) or irregularly mammillated, a feature that easily distinguishes this class of rock from other forms of alluvia, while the quartz grains retain their rounded form and have no crystalline continuity with the introduced silica which is of a colloid nature. As these consolidated masses occur scattered over the fields the farmers have much trouble with them. Some are gathered into heaps on the field or dragged to the boundary, but where the rock is in sheets and compact masses the only means of getting rid of it is either by blasting or the cheaper method of lighting a fire on the top to cause it to split.

I was informed that, in the south-west corner of the adjoining Hundred of Willowie, Mr. Chas. Fuller sank a well near his house, and at a depth of 20 feet entered sand, and that this was generally the case in the valley.

The bed-rock, when met with, is usually a decomposed kaolinized slate, as generally happens when slate occupies the bed of these ancient rivers. Mr. Brooks informed me that he put down a well in which he passed through 200 feet of pipeclay. At White Cliffs [Sec. 64 Hundred of Booleroo] a knoll has been worked back to a cliff 20 feet in height, consisting of kaolinized slate very white and apparently pure. It has been quarried and sent to Port Pirie for making retorts.

(4) *Mount Remarkable.*—Mount Remarkable, as already stated, forms a part of the western boundary of the Willochra plain. Saddle Hill, situated opposite to the township of Melrose, takes its name from the saddle-like shape of its summit, and is one of a series of foothills that surround the mount on its south-eastern and southern sides. The hill is roughly guessed as being 200 feet in height. The lower part, facing the Mount Remarkable Creek, consists of slates and thinnish beds of quartzite, more or less rotten. Resting

on this old shelf of rock are high-level gravels exposed on the side of the hill facing the mount where a gully has been cut out. These old gravels are capped by scree material. The Saddle Hill is connected with a still higher foothill behind it, estimated at 300 feet above the creek (which flows at the base of the mount), and the old conglomerate passes up the sides of this higher foothill which, latter, forms a ridge parallel with the mount. From this point a fine panoramic view is obtained of the Willochra plain, across to the eastern heights, which has all the appearance of having been at one time a great waterway. It does not seem at all likely that these high-level conglomerates had a local origin and are probably remnants of the older river system.

The Willochra Creek drains the highlands on either side of the plain, and takes its rise near the crest of the east-west fold, receiving numerous head-waters from the Bangor, Murray Town, and Booleroo districts.

(The Old Willochra Channel on the Southern side of the Water-parting)

Near the crest of the water-parting the drainage is much disjointed and, in many places, uncertain. Some residents in that region say that they are not sure in what direction the water ultimately flows, whether north or south. The direction changes from time to time, and is often regulated by the position in which the heaviest rain falls at different times. Townships situated near the summit, such as Peterborough, Yongala, Jamestown, Caltowie, Laura, Gladstone and Georgetown, are subject to flooding.

The extensive Willochra plain, as a physiographical feature, is continued across the water-parting where it is bounded on the eastward by the Narien Range, and on the westward by the highlands of the Wirrabara district. The respective lateral ranges feed numerous streams which follow the southern slopes of the transverse fold. Many of these unite. The three principal channels are the Rocky River, Pine Creek, and the Appila Creek; the two latter ultimately combine with the Rocky River, which finds its outlet by the River Broughton into Spencer Gulf.

(5) *Rocky River.*—Murray Town [Hundred of Wongyarra] is situated on the water-parting, with the Willochra Creek on the northern side and the Rocky River on the southern. At about a mile eastward from Murray Town is Pine Creek.[1] On the right bank of this stream, and at a height of about 50 feet above the water level, is a considerable deposit of siliceous and jaspery sandstone, sometimes changing to a coarse conglomerate having the features of the older river system.

The Rocky River, strengthened by tributaries, takes its rise in the high ground to the north-west of Wirrabara and, for a few miles, pursues a northerly course till, near the crest, it takes a sudden turn to the south-east, passing through Wirrabara and on the western side of Laura. The Rocky River answers to its name only in its upper reaches as, from Wirrabara, southward, the most of its bed is in the soft sediments of the older river channels. Near Wirrabara the river occupies a flood plain, meanders, and has incised its older bed, exposing black clay in its banks, the remains of a former swampy basin. A little further to the southward, between the 151 and 152 mile posts on the railway (about two miles north of Stone Hut), there are considerable deposits of the consolidated and siliceous gravels.

(6) *Pine Creek Tributary.*—Booleroo Centre, like Murray Town, is on the crest of the fold, at a height of 1,300 feet above sea-level. The country on the southern side of the above township has a very broken drainage for a few miles.

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(1) This creek flows into the Wild Dog Creek, the most southerly head-water of the Willochra Creek, and is quite distinct from a creek of the same name that takes its rise a little to the southward of Booleroo Centre, which will be referred to later. [See same page.]

The most persistent stream is Pine Creek which, with its origin in the Hundred of Booleroo, flows in a wide valley, southwards, through the Hundred of Appila and northern portions of the Hundred of Booyoolie, joining the Rocky River at Laura.

(7) *Appila Creek Tributary.*—This is the third important creek that, at the present day, crosses the wide valley lying between the Wirrabara hills on the west and the Narien Range on the east, forming part of the southern slopes of the transverse fold. Its head-waters are near the Hogshead Hill, Hundred of Pekina, and is the principal outlet for the drainage from the western side of the Narien Range. It passes through the Hundred of Tarcowie, and is there noted for a fine section of the Sturtian Tillite, half a mile in length, forming the most westerly gorge of the stream. [Howchin, W., "Glacial Beds of Cambrian Age in South Aust.," Q.J.G.S., lxiv., 1907, pp. 234-258.] At the mouth of the gorge a massive and nearly vertical quartzite underlies the tillite, rising like a huge rampart through which the creek is at present eroding its bed in rapids and waterfalls. On emerging from the gorge the creek enters the ancient valley and immediately loses its energy and fails to incise its bed, and, in places, overspreads the public road. At Yarrowie it is lost in swampy ground, but in flood times sometimes reaches Pine Creek.

(8) *Laura.*—The valley at Laura is bounded on its western side by the White Cliff Range, which forms the eastern boundary of the Wirrabara Forest Reserve. The Rocky River flows through the alluvial flats on the eastern side of the range mentioned and passes within half a mile of the township of Laura. The river is sluggish and has a pebbly bottom between waterholes. At a bend of the river, near Laura, the section shows sandy clay interspersed with beds of small gravel. The banks reach a height up to 20 feet. Laura is, unfortunately, situated with the Appila Creek and Pine Creek converging on the township, which occasions flooding and has necessitated the erection of mud banks to protect the township. Pine Creek comes in from the north-east with alluvial banks which, in places, are 20 feet in height, and, in others, flows across the main road at water-level in the form of several branches. The flow of water in the creek has been intermittent. It is supposed that, at times, the water finds an outlet through other channels. Near the Laura Railway Station a quarry has been worked in a gritty, mottled red and white sand-rock, having a visible thickness of 15 feet without the floor being exposed. The bed forms a terrace which was probably laid down by alluviation during the older river system.

(9) *Gladstone.*—After passing Laura, the valley of the Rocky River continues in the same direction to near Gladstone, a distance of seven miles, with a fall in altitude from 813 feet at Laura, to 740 feet at Gladstone. The railway from the south, after following a moderate plateau, passes down into the Rocky River valley, which is a striking feature. The valley is a flood-built one, two miles wide—a well-defined flat—and carries heavy timber. Gladstone is above the flood level of the Rocky River, but is subject to inundation from the plateau streams which come in from the Caltowie country, on the north, including the Pinery Creek and the Yangya Creek, which unite to form the Pisant Creek, against which Gladstone has had to be protected by a drain. The Rocky River valley, near Gladstone, is separated from the Yackamoorundie Creek, on the eastward, which belongs to another main line of ancient drainage, by a low ridge. Near Gladstone the Rocky River faces the Mount Herbert ridge, and is deflected thereby to the south-west, following a serpentine course between the townships of Crystal Brook and Narridy, and, after taking a new direction to the north-west, unites with the River Broughton on the coastal plains. By this north-westerly bend the Rocky River intersects a former tributary of the main northerly stream that follows the Willochra channel. This extinct tributary came down from the

north-west and united with the main river somewhere in the neighbourhood of Crystal Brook or Narridy, to which our attention must now be directed.

VI. A NORTH-WESTERLY TRIBUTARY OF THE ANCIENT WILLOCHRA CHANNEL.

(1) *Plain on the Western side of the Southern Flinders Ranges.*—At the time when the drainage from Central Australia came through to the southern coast the two gulfs were, practically, non-existent, and the areas they now cover formed extensive gum-plains at a greater elevation above sea-level than at present. The Finke River, in its southern extension, probably followed somewhere near the central portion of the present Spencer Gulf. There would thus be a trunk line of drainage on the eastern side of the Southern Flinders Ranges [the Willochra channel], and another through Spencer Gulf. As the latter has a trend in a south-westerly direction, there would be a very extensive plain between the extended Finke River and the western scarp of the Southern Flinders. Within this latter area there appears to have been a tributary stream which took a south-easterly course and united with the trunk river which, in the line of the present Willochra Creek, followed the eastern side of the ranges, the two streams meeting in the neighbourhood of Crystal Brook or a little further to the southward.

At the present time the coastal plain from Port Augusta, southwards, to Port Pirie, has an average width of ten miles. Numerous small streams drain the Southern Flinders Ranges on to the plain, but of these only one or two are able to maintain their course to the gulf, being absorbed by a great thickness of alluvium. Mr. Henry Williams, of Telowie [Port Germein Plain], informed me that he had sunk several wells in this neighbourhood to a depth of 130 feet and passed through alternating beds of clay and gravel without reaching bed-rock. The same informant stated that the deepest well in the neighbourhood, up to that time [1904], was sunk by Capt. Kingcombe, to a depth of 180 feet, without touching bottom. Alluvial fans form aprons at the outlets of the small streams from the Flinders Ranges, but it is doubtful if they can account for the enormous deposits of alluvial sediments that extend over so wide a plain and to such unknown depths.

(2) *Port Pirie.*—A Government boring, carried out at Port Pirie, in 1898, reached a depth of 641 feet, the material from which was critically examined by the late Prof. R. Tate, who summarized the results as follow:—"Passing upwards from the Cambrian bed-rock [proved at 574 feet] there are 314 feet[2] of unfossiliferous beds, more or less carbonaceous. These indicate a land accumulation. . . . The succeeding 182 feet of sandy and clayey beds, though unfossiliferous, have so much the character of the overlying strata with marine shells that they may be reasonably regarded as forming part of the same series. The chief fossiliferous beds range between 90 and 150 feet, but in the midst of them, at about 130 feet, is a band of calcareous silt charged with *Plecotrema ciliatum,* in an excellent state of preservation. This pulminiferous mollusc is living at extreme high tide-mark in the marine marshes abutting on the Port Creek, whilst the fine calcareous silt is analogous to the shell-travertine which delimits the margin of an upraised Pleistocene sea-bed extending from Glenelg, *via* Dry Creek, to

(2) Tate's figures in this paragraph show discrepancies with those contained in his table of strata, which are as follow, with the classification modernized:—

Recent:	Surface clay and 2 marine horizons separated by a terrestrial zone	150 feet
Pleistocene:	Sand-rock, mottled clays, etc. (?)	210 "
"	Sand-rock, clays, bituminous clays, etc.	214 "
	Bed-rock at	574 feet

beyond Virginia. This ancient silt is indicative of an actual depression of 130 feet below high water-mark. . . . The total amount of depression is a few feet less than 150 feet below high water-mark." [Tate, Roy. Soc. S. Aust., xxii., pp. 68-71.]

This boring has several interesting features. It proves the bed-rock of the Adelaide Series at Port Pirie, in Spencer Gulf, as over 1,600 feet nearer the surface than in the Croydon Bore, near Adelaide. In the latter bore fossiliferous Miocene, as well as Older and Newer Pliocene beds, are represented, but are absent at Port Pirie. In the latter only two (other than the bed-rock) distinctive formations occur:—*(a)* a lower alluvial series with a thickness of 424 feet; and *(b)* 150 feet of fossiliferous silts of Recent age, including a zone of dry land conditions. The fossiliferous beds can be definitely referred to the raised (as well as sunken) estuarine beds of the Port Adelaide flats, but, what of the 424 feet of underlying alluvium? It is possible that it may represent, in this case, the freshwater series that underlie the fossiliferous Miocene in many places, with the marine beds wanting; but the surroundings seem to suggest a more recent origin. The amount of land-wash carried into Spencer Gulf from either side, at the present time, is a negligible quantity. It seems more likely that the sands and carbonaceous clays of these beds represent the sediments of the older river system, when the drainage from the interior of the continent found its outlet to the south and before the sea had penetrated so far up the alluvial valley as the site of the present township of Port Pirie. [See below, Port Moonta, this Section, No. 9.]

From Port Pirie the valley goes in a south-easterly direction, now occupied by the River Broughton, which, from following a southerly direction, becomes reversed to a north-easterly one, passing the townships of Koolunga and Red Hill on its way to the sea.

In the Hundreds of Crystal Brook and Narridy there are extensive deposits of ancient river alluvia.

(3) *Crystal Brook.*—The stream, from which the township takes its name, flows through a rocky gorge until about half-a-mile from the latter, but, below that point, it has cut its way through clay and other alluvia, with banks up to 15 feet in height. On the rise of the hill at the back of the township, joined on to the parklands and situated behind Mr. Chas. Nailson's house, there is an ancient river flat margined by consolidated alluvium, having a fine grain and highly siliceous. The formation begins near the entrance to a large quarry worked for kaolin for the Port Pirie smelting works. The kaolin rock is really the Tapley's Hill slate rock that formed the bed of the ancient river, and was probably acted upon by the water of the stream causing its alteration to a very white and pure kaolin. The solidified alluvial beds, just described, after following a north-westerly trend, make an angle at the curve of the hill and strike north-easterly. The rock has the usual reddish stain and is developed in large tabular and rounded masses.

(4) *Narridy.*—The Hundred of Narridy adjoins that of Crystal Brook. In Section 220, close to the border of the Hundred of Crystal Brook, on Mr. W. F. Nicholls' land, on the northern side of the Rocky River, an ancient river flat caps a relatively high ground and the consolidated alluvium follows the curve of the ridge. Several exposures follow a north and south direction, the largest is 300 yards long by 60 yards in its greatest breadth. There are similar deposits on the ridge situated on the opposite side of the road, in Section 221, and at about the same elevation as the one just described. One of the most extensive deposits of this class of rock that the writer has met with occurs near the township of Narridy, situated about three miles in a south-easterly direction from those just described. The formation rests chiefly on the higher levels of the Narridy Creek, on its left banks, commencing on the parklands of the township and occurs at

intervals for about a mile in a direction westerly from the township. One solid mass covers about half an acre of ground, near the township. The exposed rock, facing the valley, has been undermined to some extent and large masses have fallen over, leaving a sheer wall of solid siliceous rock 12 feet in height. The scarp face of the rock appears to preserve the same level, as far as could be seen from the Narridy end, throughout its extent.

Mr. W. F. Nicholls informs me that the same class of rock occurs on either side of the main road to Narridy, about two miles out from Crystal Brook, in Sections 756w and 757 [Hundred of Crystal Brook]. This exposure is about midway between that at Crystal Brook and that on Mr. Nicholls' land, described above, so that the four exposures, being in a line, there is almost a continuous deposit between the townships of Crystal Brook and Narridy, a distance of about nine miles.

The valley is continued southerly to the township of Red Hill [otherwise Broughton], which takes its name from a prominent hill or ridge in its neighbourhood consisting of a reddish quartzite belonging to the Purple Slate and Quartzite Series of Cambrian age. The hill affords a good view of the plain, with the tortuous River Broughton sunk in the alluvium below surface level, and can only be recognized from the hill by the trees growing within its limits.

5. *River Broughton.*—The River Broughton takes its rise in a number of head-water streams, variously named, among the ranges to the westward of the Burra. While these tributaries pursue courses mainly longitudinal to the grain of the country, The Broughton, as the main stream, runs transversely to the ranges. From Yacka [Hundred of Yackamoorundie] the river has cut its bed through a country of subdued relief until, at about the dividing line between the Hundreds of Yackamoorundie and Koolunga, the river emerges from its gorge and enters on the wide alluvial plain of the older river system. From this point its course is a strongly characteristic meandering stream of canyon type, with steep banks about 15 feet to 20 feet above the normal level of the stream. Near the adjacent boundaries of the Hundreds mentioned the river has some interesting features. It has recently [observations made in 1911] cut its floor deeply into a black, tenacious clay that formed a prehistoric marsh or swamp. The stream is here divided, one portion flowing over a gravelly terrace [its original bed] at a high level, and the other flowing over the side into a black-mud-ditch six feet below. From the yielding nature of the material this difference of level has probably long since been adjusted. Near to the above feature the bed of the stream consists of a firmly cemented, coarse conglomerate with a scoured surface. In this hard bed the river has cut a trough four feet deep with steep walls and is cutting back by a waterfall. This indurated bed probably belongs to the older alluvium which occurs plentifully over this plain.

In the neighbourhood of the black-mud deposit several large pieces of a fossiliferous mudstone were found among the boulders, in the bed of the river, containing many fresh-water shells. Examples of this bed were also found, *in situ* in the banks, about 15 feet above the present level of the stream. In approaching the higher ground, near the boundary of the Hundreds, four or five river terraces can be recognized as marking former levels of the river. The Broughton is evidently a juvenile stream, and from the yielding nature of the material within its bed is undergoing rapid change. The river is apparently superimposd on the older system, the sediments of which it has eroded and, in places, laid down thick sediments within such eroded areas.

(6) *Koolunga.*—The Koolunga township is situated at the most southerly bend of the River Broughton, on a wide flood-plain consisting of fine silt with sandy patches. The secondary drainage of the plain is of a fragmentary kind confined to temporary streams that seldom reach the centre of drainage. Red Hill

is 300 feet above sea-level, and Koolunga cannot be much higher. From this position there is a gradual slope of the ground southwards to sea-level at the head of Gulf St. Vincent. I was locally informed that in flood times the river sometimes overflows its banks, especially between Koolunga and Red Hill, flooding both sides, but especially the southern side, where its inundation covers the land to a width of half a mile and fills up the shallow depressions between the river and Snowtown. This was, no doubt, the older line of main drainage, and at one section of the river course, where flooding takes place, the latter has built up levees by its sediments, so that the river appears to follow higher ground than the land on either side.

A special feature of the district is the occurrence of large rounded or irregularly-shaped masses of very siliceous rocks, caused by the infiltration of colloid silica and a consequent consolidation of the sand grains into a chalcedonized rock. The thickness of these siliceous layers varies from a foot or two up to six feet, probably more. The rock has a good choncoidal fracture which has been utilized by aborigines for the manufacture of their implements. These consolidated beds are not confined to the neighbourhood of the river but pass inland and occupy the tops of low knolls in paddocks that can be traced for miles. Mr. Jones, of Koolunga, informed the author that where they occur in paddocks, in a size too large to move and too hard to break, the farmers here, as noted elsewhere, light fires on and around the masses, when they split into pieces.

(7) *Snowtown and Bumbunga Plain.*—The two important rivers that have just been sketched; one that followed the southerly extension of the channel now occupied, in part, by the Willochra Creek; and, the other, a tributary that came in from the north-west, formed a junction on an extensive plain between Crystal Brook and Koolunga. On this plain the present Rocky River, Yackamoorundie Creek, and River Broughton converged in finding their way to Spencer Gulf. Had it not been for the downthrow to the west, by the great meridional fault, all these streams would have followed the plain southwards in the line of the great trunk drainage that came in from the north.

From Koolunga the plain widens out to the head of Gulf St. Vincent. From Brinkworth on the east, to Snowtown, on the west, it has a breadth of ten miles. From Blyth, on the east, to the western side of the Bumbunga Lake, it has a breadth of 19 miles. The plain is margined on the western side by the Hummock and Barunga ranges, and on the eastern by low ranges of the Adelaide Series. The southern portion of the plain is divided longitudinally by a low central ridge of the older rocks which probably divided two waterways in former times. The ancient line of drainage on the western side of the plain is marked by a large number of, so called, salt lagoons, the largest of which is the Bumbunga Lake, that is six miles in length and yields much commercial salt. The plain is continued southwards, where it is known as the Gawler and Adelaide plains; and on its western side has suffered drowning by the waters of the Gulf. The railway between Balaklava and Brinkworth, a distance of 37 miles, follows the base of the eastern ranges, the small creeks from which have cut deep canyon-like courses through the alluvial clays. Towards the centre of the plain sand-ridges occur which, in places, are affected by wind-drifts.

(8) *Port Wakefield.*—In 1879, the Public Works Department put down a bore near this township, in search of water, to a depth of 765 feet. [See Rutt, W., Trans. Roy. Soc. S. Aust., iv., 1880-1882, p. 41.] The upper 66 feet of the boring passed through two marine beds of Recent age, separated by a series of fresh-water alluvial beds. From the 66-feet level down to 302 feet, the section showed

various coloured clays, quicksands, sandstones, ironstones, and fragments of decayed wood, presumably of Pleistocene age. Bed-rock was proved from 302 feet to 765 feet, in blue shale. The section is closely analogous with that passed through on the verge of Spencer Gulf, near Port Pirie [see p. 124]. The two marine horizons, represented in each, being the upper and lower Recent fossiliferous beds commonly present at about sea-level near Adelaide. The freshwater alluvium, of 236 feet, underlying the Recent beds at Port Wakefield, corresponds to the 214 [or 424] feet of similar beds in the Port Pirie bore. As the latter probably marks the southern extension of a former northern river coming down from the western side of the Southern Flinders, so the boring at Port Wakefield probably penetrated the alluvial sediments associated with a similar river, now extinct, which came down the Snowtown plain into the former terrestrial flats now occupied by Gulf St. Vincent.

(9) *Port Moonta.*—Pleistocene terrestrial beds occur in the cliffs and on the beach at the jetty, Port Moonta. The geological face shows three very distinct formations. The lowest is a consolidated alluvium, which, on account of the infiltration of iron oxide and silica, possesses very diversified features. The sedimentary element varies from very fine silt up to gravel, changed by the introduction of colloid silica (as an interstitional cement) into a very compact rock. In the finest grade of sediment it takes the form of a translucent flint in irregular layers, the iron oxide showing as reddish streaks. The bed is not fully exposed but in the cliff-face has a height of 10 feet. It occupies the whole of the beach to low-water level, in a length of 200 yards. On the northern side of the jetty there are immense blocks which have been left, *in situ,* at about half-tides, which the sea has failed to break up in its encroachment on the land. Resting on this lowest bed is a highly-coloured, gritty, ferro-laterite, 10 feet in thickness, and on this latter is a light-coloured calcareous marl, in a thickness of 20 feet. At about the middle of this bed is a bed of rather large nodules of travertine, 18 inches in thickness, and near the top of the cliff, another bed of smaller concretionary nodules. The whole section is unusual. It can possibly be correlated with the alluvial beds present in the Port Pirie bore. The difference in the respective lithological features may be accounted for, partly, from their different positions. The beds at Moonta are situated 66 miles to the southward of those at Port Pirie, and 26 miles more to the westward; and while the Port Pirie beds are at a depth of 150 feet, and protected by a thick covering, the Moonta beds, at or near the surface, have been subjected to conditions favourable for collodial silicification. It may be that the Moonta occurrences form an isolated fragment of a tributary stream which, taking its rise on the higher ground to the eastward, went westerly and united with the main trunk river that flowed down the valley of the present gulf.

VII. ANCIENT RIVER CHANNEL BY LAKE FROME AND ORROROO.

(1) *South-Western Queensland Drainage.*—The sag in the earth's crust, which gave rise to the Lake Eyre Basin, revolutionized the hydrographic system of Western Queensland and directed to the westward many streams that formerly had a more direct course to the southward. The Barcoo, or Cooper's Creek, during heavy floods spreads itself over the plain and is many miles wide. Near Innamincka, the flood waters divide; one branch (The Cooper) goes westerly to Lake Eyre, another (the Strzelecki Creek), goes southward and fills up the group of lakes that form a semi-circle around the head of the Flinders Ranges, terminating to the southward, in Lake Frome, which forms a secondary basin, receiving its supplies from all sides. The most important tributary at the southern end is the Pasmore River, or Wilpena Creek, which takes its rise in the Flinders Ranges. The Siccus

River, discovered and named by Eyre (meaning *dry)*, takes its rise a few miles to the northward of Carrieton, and as a wide flood stream flows into the Pasmore River, another example of a reversed stream incidental to the earth wave.

(2) *Siccus River Plain.*—Between Lake Frome and Orroroo is a valley, or plain, several miles in width, having a gentle slope to the north, drained at its northern end, as described above, by the Siccus River. That this clearly-defined plain has been formerly the course of a great river is beyond doubt. The streams that drain into it from either side are soon lost by absorption in thick sediments of sand and gravel that have built up the plain.

(3) *Walloway Creek.*—The Walloway Creek takes its rise on the water-parting between the Orroroo and Willochra valleys, at a height of about 400 feet above the plains in the neighbourhood of Eurelia. After flowing for about ten miles in a south-easterly direction it takes a curve to the eastward and is quickly lost in the alluvium of the Walloway plain, which forms a part of the Orroroo plain. From the Walloway railway station the creek has cut a deep gorge through the rocks of the Adelaide Series and, towards the plain, the creek bed and sides exhibit a great mass of very siliceous consolidated gravels and sands that have no relation to the present deposits of the creek, which seem to rest unconformably on the older series. The thickness of the latter is not revealed, but they descend below the present level of the creek. They show regular bedding in vertical cliffs up to 20 feet, and extend along the creek in a continuous outcrop for more than a quarter of a mile, after which they become obscured by the recent sands and clays of the plains. [See pl. v., fig. 1.]

(4) *Lower Pekina Creek and Orroroo.*—The important Pekina Creek, situated on the northern side of the Orroroo township, is a roaring torrent in flood time, but never reaches further than two miles on the flat before it becomes absorbed. Near the place where the creek ends a Government bore, put down in 1907, reached a depth of nearly 600 feet, and was abandoned before reaching bed-rock.

The following are particulars of this bore. Height above sea-level about 1,315 feet.

	Thickness, Ft.	In.		Thickness, Ft.	In.
1. Loam	37	0	13. White Sand	28	0
2. Gravel and Clay	40	0	14. Fine White Sand	11	0
3. Sand and Limestone	1	6	15. White Clay	9	0
4. Yellow Clay	10	0	16. White Sand	8	0
5. Sand	0	6	17. Clay, White and Pink	52	0
6. Clay	68	0	18. Quartz Sand	2	0
7. Sandy Clay	5	0	19. White Clay	8	0
8. Various Coloured Clays..	168	0	20. Quartz Sand	18	0
9. Pipe Clay	20	0	21. Sand and Pebbles	17	0
10. Sand and Clay	27	0	22. Sand, Lignite and Clay	21	0
11. Clay	3	0	23. Quartz Sand and Clay	15	0
12. Soft White Sandstone	14	0	24. Sandy Clay	8	0
			Total proved	591	0

The great thickness of fluviatile sediments, as proved in the above bore, without reaching their total depth, cannot be accounted for by the present discharge of alluvia from existing streams that find their way to the plain. There is also evidence that the present surface of the plain is being lowered rather than raised, as noted below.

The significance of so great a thickness of sediment having been laid down in this unusual situation is apparent. Orroroo is not much below the crest of the watershed. A water-parting is necessarily under the conditions of denudation and waste and is incapable of conserving such waste. The thick alluviation of the plain at Orroroo is proof that such sediments antedated the development of the newer water-parting. In the elevation of the transverse ridge the tilting of the ground (passing from a southward to a northern direction) would be gradual, and at one particular stage in this process of reversal the grade would become horizontal, forming a local base-level and rapid silting. This may explain the presence of thick sediments in the present Orroroo plain that accumulated under former conditions and at a later stage were elevated to a position near the summit of the ridge.

As the Pekina Range comes close up to the plain on its western side it is seen that the lateral drainage has been truncated by the lowering of the plain. Behind Mr. Judell's [now Mr. James Chrystall's] house, in Winowie Creek, near Orroroo, a fine section of the old gravels is seen resting on kaolinized shale. The cliffs, in places, are 40 feet high, and the undermining of the latter by the stream, operating on the soft underlying shales, has brought down great masses of the indurated gravel beds. The remains of an extinct lake in connection with the Pekina Creek, near Orroroo, consisting of a fresh-water limestone [*Chara*] and fresh-water molluscs in clay, reveal the presence of an ancient back-water from the river that once flowed southward along the adjoining plain. These lacustrine remains form a scarp and are now about 150 feet above the plain [See Howchin Trans. Roy. Soc. S. Austr., xxxiii. 1909, pp. 253-261, pls. xvii.-xviii. Also Howchin's "Geol. of S. Aust." (2nd ed.), figs. 145 (1-2) and 146.]

At Orroroo the valley-plain is about seven miles wide. At about two-thirds of the distance across, towards the Peaked Hill, there are low knolls of rotten slate much kaolinized. On these slates, Yadena Creek, fed by springs, occupies a shallow bed. The water in the creek is very salt and continues, more or less, for four miles, but has practically no current. The springs are evidently artesian.

On the eastern side of the plain between the low ridges of slates, mentioned above and the main range of the Peaked Hill, there are terraces of gravel and indurated sands. The fields are very stony. The alluvial terraces fringe the range and pass through the gap between the Peaked Hill and the Black Rock, marking a line of tributary drainage coming in from the north-east. The main plain was followed by the writer for 16 miles in a northerly direction, through the Hundred of Yalpara, the alluvial features being continued the whole of the way.

The central portions of the plain consist of very fine silt, or loess, but towards the margin, on either side, as already stated, the drainage lines are at discordant levels with the plain by truncation. This lowering of the level of the plain has been caused chiefly by wind action. The soft, loose soil, in a bared condition during the summer, is in constant motion by the wind at that season of the year. Mr. Bradley, who was resident engineer during the construction of the Pekina Creek reservoir, informed me that when surveying on the adjacent plain he sometimes counted as many as 26 whirlwinds in operation at the same time.(8) The Orroroo plains are a fruitful source of the high-level duststorms that obscure the sky in Adelaide during the summer.

Between Orroroo and Mannanarie, a distance of 20 miles, the valley is bounded on the western side by the Pekina and Narien ranges, and on the

(8) In the paper referred to above it is stated that the 26 whirlwinds occurred in one day. This was subsequently corrected by Mr. Bradley to 26 at one and the same time.

eastern by the Black Rock and Peterborough ranges. The rise of the ground to the southward causes the flood waters coming from the Mannanarie and Yatina districts to sweep in a broad sheet over the paddocks, crossing the railway a little to the southward of the Black Rock railway station, the line passing over a lengthy wooden viaduct under which the water finds a passage and spreads itself till absorbed in the light, sandy soil. At Yatina the public school teacher sunk a well in alluvial deposits to a depth of 60 feet without reaching bed-rock. Near the depth mentioned a fossil bone was found but not identified.

(5) *Caltowie.*—The valley from Orroroo is continued through the south-eastern portions of the Hundred of Tarcowie, into the Hundred of Caltowie, where it assumes wide dimensions that take in most of the Hundred with a low plateau in the centre, Caltowie Hill being the highest point. On the western side of the township there are some remarkable remains of the older river deposits, situated on the higher ground. In Section 152 [Hd. Caltowie], on the western side of the north and south road, there are large patches in cultivated ground. Some exposed blocks weigh several tons, and others have been dragged to the edge of the paddock, near the road. [See pl. v., fig. 2.] The stone is a light coloured (sometimes tinged with red), massive, very tough, fine-grained, siliceous rock, too tough to be used as road metal. A terrace of a similar kind occurs in the same paddock at a higher level. In Section 154 S, about half a mile from the preceding, in a south-easterly direction, is another capping of a like kind, but coarser in its texture.

(6) *Yackamoorundie Creek and Hundred of Yangya.*—The Yackamoorundie Creek takes it's rise a little to the northward of Caltowie, and flows southward through the Hundreds of Yangya, Bundaleer, Narridy, and Crystal Brook, becoming outspread and marshy in the latter, overflowing into the Rocky River, and finally, by a junction with the River Broughton, reaches the sea. Throughout its course it is a juvenile stream, confined by mud banks that have been eroded in the sediments of the ancient Lake Frome-Orroroo valley as far as Georgetown; then, taking a westward direction, it intersects the more westerly parallel trunk line of drainage which represents the dead end of the Willochra channel, indicated, broadly, by the Rocky River valley. Of these two important ancient waterways, the more eastward has the greater elevation and is separated from that more to the westward by a broad plateau of moderate altitude.

In the Hundred of Yangya some important terraces of the ancient river deposits occur on the higher ground, about three and a half miles to the north-eastward of Gladstone, in a line with similar deposits in the Caltowie Hundred mentioned in the preceding paragraph. One of these forms the top of a rise, in Section 157, situated on the western side of the railway, and consists of a coarse conglomerate, strongly cemented, containing rounded pebbles, some of which had a length of five inches. A still more striking platform of these rocks occurs on the opposite side of the railway, in Section 160, capping a hill with large blocks that can be easily seen from the train, and which, on examination, proved to be a coarse conglomerate, composed almost entirely of white-quartz pebbles which, on breaking, fractured evenly with the matrix.

(7) *Georgetown.*—The productive and extensive valley, already noticed as passing through the Hundred of Yangya, maintains its features throughout the Hundred of Bundaleer, with the Campbell and Never Never ranges forming its eastern boundary. Georgetown is situated at the north-western angle of the Hundred, 896 feet above sea-level, which is 156 feet higher than Gladstone, on the western side, in the Rocky River valley. Georgetown is built within the flood areas of the Yackamoorundie Creek, a defect that has given much trouble to the residents of the township. The creek mentioned spreads out into an ill-defined

swampy channel, but in a westerly turn it becomes more defined and ultimately enters the Rocky River as already described. This ultimate westerly tendency in the existing river system is very marked.

(8) *Gulnare and Yacka.*—South of Georgetown the valley takes the name of the Gulnare Plain, margined by a continuation of the Bundaleer hills on its eastward side and the less prominent Mount Herbert ridge on the westward. The railway, going south, follows the valley. A little to the southward of Gulnare railway station, on the western side of the railway, a patch of consolidated alluvia occurs in ploughed land. A little further to the southward, on the eastern side of the railway, similar consolidated beds form an ancient river terrace. There is also a succession of such deposits following the banks of a small creek. Still further, on the western side, in grass land, there are several more exposures, near a farmhouse, including a hill showing extensive faces of the alluvial sediments.

The surface shows a gradual slope from Georgetown [896 feet] down to Yacka [563 feet], situated on the banks of the River Broughton. This river takes its rise in the Bald Hill Range, north-west of the Burra, and cuts its way transversely through, first, the Camel's Hump and Brown's Hill ranges, and then through the Bundaleer and Mount Gregory ranges in a rocky gorge to Yacka, from which, in subdued physical features, it flows westerly to Koolunga and Red Hill, and enters Spencer Gulf a few miles to the southward of Port Pirie. Between the respective ranges, just mentioned, is a subsidiary valley that carries three important tributary streams that have a north and south direction, and meet the Broughton in a knot near Spalding. These are the Freshwater Creek, coming in from the northward, and the Hut and Hill rivers, following parallel courses, come in from the southward. These will be referred to again in a further paper on this subject.

There are some remarkable deposits of gravels, both loose and cemented, in the neighbourhood of Yacka. In Section 96 [Hundred of Yackamoorundie], about a mile on the northern side of the township, there is a strong craggy hill capped by cemented gravels, 120 feet above the present level of The Broughton, held together in a siliceous and ferruginous matrix. Just south of Yacka railway station there are several railway cuttings in gravel, about 70 feet above the present level of the river. These beds are unconsolidated and have been greatly used in ballasting the line, and may be younger than the siliceous beds on the northern side of the river. In Section 160, on the southern side of Yacka, there is another very craggy hill, the cemented alluvia resting on older quartzites. These consolidated gravels have a north and south extension of about three miles, and from appearance (with less conspicuous gravelly character) continue nearly to the top of the saddle on the railway passing over to Brinkworth. Sandy Creek, which flows into the River Broughton on the southern side of Yacka, occupies the valley southwards, having its origin a little to the north-eastward of Brinkworth. In the Sandy Creek the following exposures of the siliceous alluvia were noted. Near the Yacka railway station, on the western side; at one and a half miles from the station, on slopes of the valley; patches at high levels on both western and eastern sides; two and a half miles from the station, on western side, a small hill is capped by these gravels, also a patch further to the southward; again, on ploughed ground, are numerous heaps of big stones gathered into centres on those *in situ*.

(9) *Rochester and Magpie Creek.*—The Sandy Creek, flowing northerly, takes its rise on a low ridge in the Hundred of Hart. On the same ridge and within a few yards of the latter are the head-waters of the Magpie Creek with a flow south-westerly. The last-named, formed by the convergence of three head streams near the school-house at Rochester, passes to the southward of Brinkworth and is absorbed in the sediments of the Snowtown plain. The consolidated gravels,

so prevalent in the valley of the Sandy Creek, pass over the water-parting into the Magpie Creek country, near Rochester, about four miles to the eastward of Brinkworth. Here are seen the most extensive and prominent displays of the ancient consolidated alluvia found within the State. [See fig. 3.] [4] The surface features are distributed over an area two miles square and make large patches of ground uncultivable. In Section 317 [Hundred of Hart], on the right bank of the more northerly of the tributaries of the Magpie Creek, exposures of these rocks cover half an acre. Between the northern and middle tributaries there is almost a continuous exposure (occurring at intervals of from three to four chains) for two miles, passing through Sections 317, 316, 311, 310, 304, and 305, in two lines, an upper and a lower one, some examples having a height of from

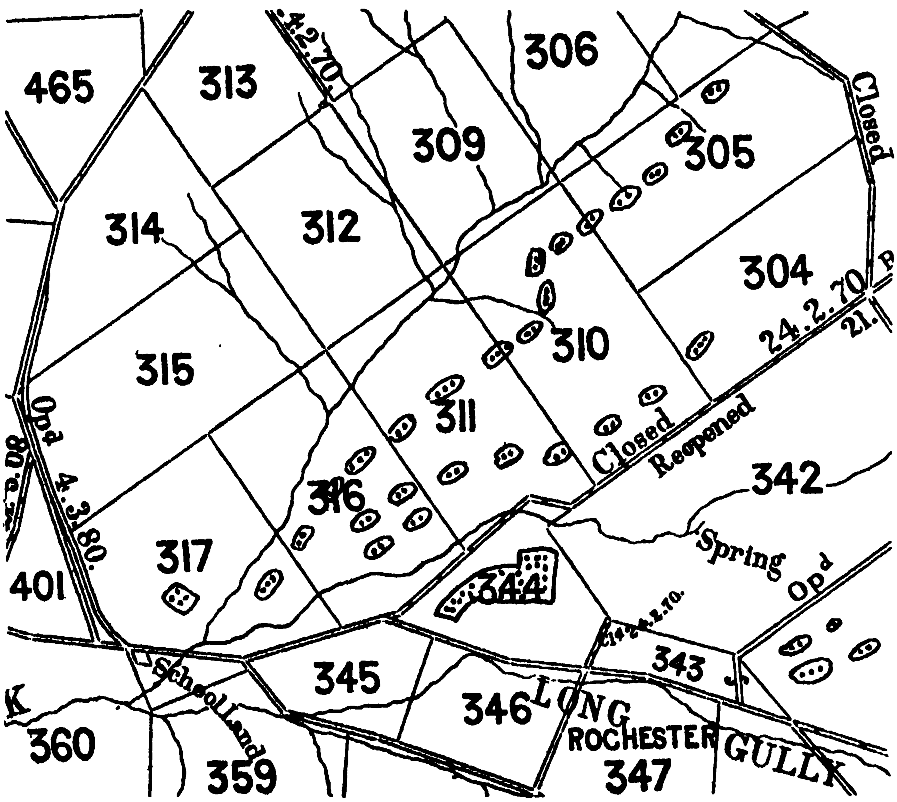

Fig. 3.

Part of Official Map of the Hundred of Hart [Scale, 2 in. to 1 mile], on which is shown the positions of the chief exposures of the Ancient Consolidated Alluvia in the neighbourhood of Rochester and head-waters of the Magpie Creek.

eight feet to ten feet. In Section 344 there is a very imposing display of these rocks, resembling vast megalithic structures. The group extends over 10 chains in length, by 6 chains wide at the eastern end, and $1\frac{1}{2}$ chains at the western. The largest mass has a sheer face of 20 feet, and adjoining this are two great blocks with vertical faces to a height of 14 feet. The ground

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(4) I am greatly indebted to Mr. Harold Snow, of Rochester (on whose properties most of these exposures occur) for kindly piloting me over the area and also noting on the map the respective positions of the principal occurrences.

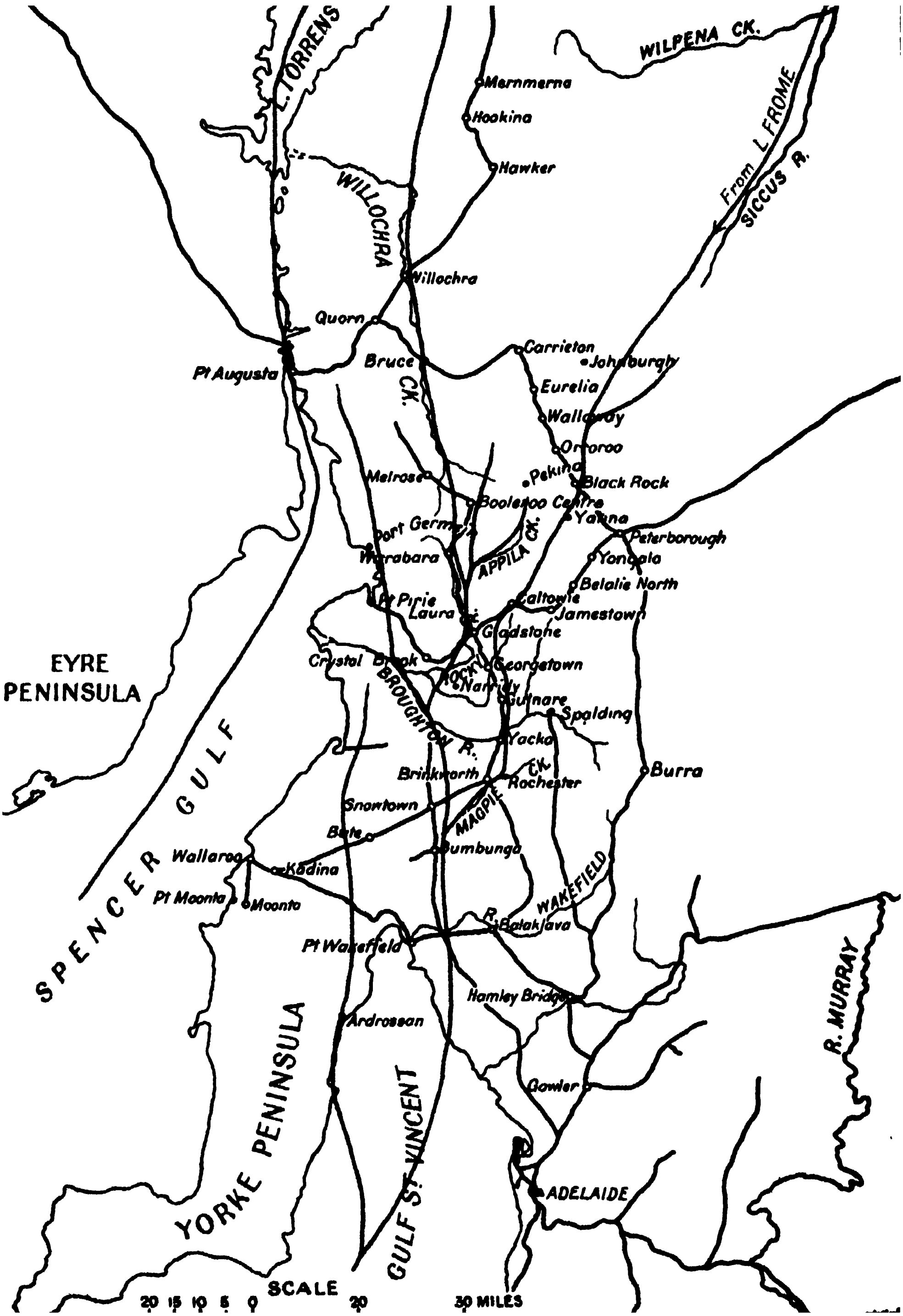

Fig. 4. Map of part of South Australia on which is shown, in red, the probable direction of some of the main river courses [the Western Group] before they were truncated.

covered by this patch of great stones is unploughable for 16 chains in one direction by an average width of 4 chains. At a mile eastward from the group just described [in Section 522] are several exposures. The three principal ones measure in circumference, respectively, 6 chains, 8 chains, and 10 chains.

Another somewhat isolated occurrence is seen in Section 454 [not included in the accompanying map], on the Michel Bros. land, about 1½ miles north of the most northerly exposures of those shown in fig. 3, situated directly on the crest of the water-parting between Sandy Creek and Magpie Creek, and, therefore, forms a link between the occurrences found in these respective valleys.

This great field of ancient consolidated alluvia is unique. The local streams are small and at a juvenile stage. One has a small permanent spring, the others are mostly dry. The consolidated sediments vary in structure from fine sand up to coarse gravel, and are often current-bedded. The lower portion of Magpie Creek is cut in deep argillaceous alluvium of Recent age. So extensive an area of water-borne heavy material is suggestive of very strong transporting currents. From Yacka, southwards, there are indications of a great river, now extinct, that can be associated with the ancient Lake Frome and Orroroo trunk-waterway that drained portions of western Queensland, and found its discharge by union with another trunk line that came down the wide Koolunga and Snowtown plain to the southern coast.

As an indication of the thick alluvial that exists in the Snowtown plain the following quotation may be given:—"In August, 1886, I observed the flood waters of the River Wakefield coming down after a long continuance of dry weather, and the progress in its channel across the plain near Balaklava was only at about the rate of half a mile in 24 hours, and frequently the head of the flood remained stationary for half an hour whilst it poured into one of the many large fissures in the river bed."—Thos. Parker, C.E., "The Underground Waters of S. Aust.," Trans. Roy. Soc. S. Aust., vol. x., p. 84, 1888.

DESCRIPTION OF PLATE V.

Fig. 1. View of Ancient Consolidated Alluvia now undergoing erosion by the Walloway Creek.

Fig. 2. Ancient river terrace of Consolidated Alluvia exfoliating into large siliceous masses. Another terrace, at a greater elevation, can be seen in the distance. Hundred of Caltowie.

ADDITIONS TO THE FLORA OF SOUTH AUSTRALIA.

No. 29.

By J. M. Black, A.L.S.

[Read October 8, 1931.]

Plate VI.

Gramineae.

Eragrostis japonica (Thunb.) Trin. in Mém. Acad. Pétersb. sér. 6: 1: 450 (1830) instead of *E. tenella,* Benth. Fl. Aust. 7: 643 (1878) non Beauv. or *E. interrupta,* Stapf non Beauv. var *tenuissima,* Stapf in Fl. Brit. Ind. 7: 316 (1897); Black in Trans. Roy. Soc. S. Aust. 48: 253 (1924); *Poa japonica,* Thunb. Fl. jap. 51 (1784). Miss C. D. Niles and Mrs. Agnes Chase in "A Bibliographic Study of Beauvois' Agrostographie," published in Contrib. U.S. Nat. Herb. 24: 6: 135-214 (1925) show that *E. interrupta,* Beauv. Agrost. 71 (1812) was based on *Poa interrupta,* R. Br. Prodr. 180 (1810), which is classed by Bentham as var. *interrupta* of *E. Brownii,* Nees, and cannot therefore be applied to the minute-glumed species which extends from Australia to Japan. Besides, *Poa interrupta,* R. Br., is invalidated by the earlier name *Poa interrupta,* Lamk. Tabl. Encycl. 1: 185 (1791), which is perhaps the same as the still earlier *Poa japonica.* (Fig. 1.)

Eragrostis confertiflora, n. comb. instead of *E. interrupta,* "Beauv." var. *densiflora,* J. M. Black in Trans. Roy. S. Aust. 48: 253 (1924); Fl. S. Aust. 674 (1929). In raising this variety to specific rank it became necessary to change the varietal name, because of the existence of *E. densiflora,* Rendle, Cat. Welw. Afr. pl. 2: 244 (1899) a species of tropical Africa. (Fig. 2.) Gramen gracile glabrum, 20-40 cm. altum, culmo binodi; foliorum laminae 3-6 cm. longae 1-3 mm. latae, vaginis longiores; ligula brevissima, truncata, ciliolata; panicula erecta, spiciformis, 6-11 cm. longa, 5-8 mm. diam., basin versus interrupta, ramis erectis, revera solitariis sed interdum glomeratim approximatis, 5-20 mm. longis, usque ad basin dense vestitis; spiculae subsessiles, confertae, 2-3 mm. longae, 4-5-florae; glumae acutae, exteriores uninerves, prima ½ mm., secunda ¾ mm. longa, florifera 3-nervis, 1 mm. longa, palea omnino glabra; stamina saepius 2; caryopsis ovoidea, brunnea, nitens, ½ mm. longa.

Eragrostis Kennedyae, F. Turner in Proc. Linn. Soc. N.S.W. 19: 535 (1894) Wirraminna, between Lakes Gairdner and Hart; May, 1931; coll. Hon. G. F. Jenkins. A slender grass, with narrow and spike-like panicle, or the branches sometimes spreading slightly, and minute purplish 3-5-flowered hyaline spikelets, the flowers almost globular and only ½ mm. long; the outer glumes 1-nerved, obtuse, ciliate on the nerve and at apex, the lower one ½ mm. long, the upper one ¾ mm. long. The terminal flower is very small, apparently always barren, and falls off early. The type came from Wonnaminta, near Broken Hill, and specimens have been collected on the River Darling and in the Murchison district, W.A. The species has, therefore, a wide distribution, although it has not been previously recorded in South Australia. The only difference perceptible in the West Australian specimen (which is in the Sydney Herbarium), is that there are some long hairs at the orifice of the leaf-sheath and the blades are rather flatter. (Fig. 3.)

The relative position of these three species may be explained by the following key:—

Rhachilla fragile, disarticulating between the flowering glumes, which fall off with their paleas and ripe grain; panicle-branches mostly solitary, divided and clothed with spikelets to base; glumes and grain minute, the latter brown, shining, barely ⅓ mm. long; palea-keels glabrous. (Section *Cataclastos*).

- **Panicle rather loose; spikelets 4-12-flowered, 2-3 mm. long; flowers oblong; outer glumes subequal; stamens usually 2 .. .. ..** *E. japonica*
- **Panicle usually dense, spike-like; spikelets densely crowded; outer glumes unequal.**
  - **Panicle always dense, 5-8 mm. diam.; ligule short, ciliolate; spikelets 4-5-flowered, about 2 mm. long; flowers oblong; flowering glumes twice as long as adjacent outer glumes; stamens usually 2 ..** *E. confertiflora*
  - **Panicle 3-5 mm. diam., or sometimes broader, owing to the slightly spreading branches; ligule a minute rim of hairs; spikelets 3-5-flowered, 1-1¼ mm. long; flowers almost globular; flowering glumes not or scarcely exceeding the adjacent outer glumes; stamens usually 3 .. ..** *E. Kennedyae*

Eragrostis infecunda, n. sp. Gramen perenne, stoloniferum; culmi ascendentes, rigidi, longi, glabri, 6-20-nodes, ad basin bulbosi; foliorum laminae involuto-subulatae, infra glabrae, erectae, 3-8 cm. longae, vaginis glabris multo longiores, inferiores planiusculae, 2-3 mm. latae; folia infima ad vaginas rigidas albas reducta; ligula ex annulo brevium pilorum constans; panicula coarctata, 3-10 cm. longa, 1-2 cm. diam., ramis solitariis, fere simplicibus, puberulis; pedicelli subnulli vel usque ad 2 mm. longi; spiculae paucae in quoque ramo, 3-8-florae, 7-12 mm. longae, circ. 1½ mm. latae, floribus saepe distantibus in rhachillâ plus minus flexuosâ; glumae exteriores hyalinae, uninerves, in carinâ scaberulae, prima circ. 3 mm. longa, secunda 3½ mm. longa; glumae florentes fuscae, glabrae, ovatae, 3½ mm. longae, 3-nerves, nervo mediano percurrente vel brevissime excurrente, lateralibus dimidio brevioribus; palea fere aequilonga, non persistens, carinis glabris; antherae 3, lineares, vix 2 mm. longae; styli ad basin coaliti; caryopsis adhuc non inventa.

Along the Gilbert and Wakefield Rivers near Riverton, and apparently propagating itself by the long rooting surface runners rather than by grain. The collector, Mr. Worsley Johnston, after careful search during March and April of this year, was unable to find any fruits. Until ripe fruits are discovered, it is difficult to say how the rhachilla breaks up, although it is apparently not persistent. In its straggling, wiry stems, and its rather loose spikelets, this grass bears some resemblance to a slender form of *Glyceria ramigera,* but in the latter species the midnerve of the flowering glume ends at some distance below the summit, while in *Eragrostis infecunda* it is always percurrent. (Fig. 4.)

Agrostis limitanea, n. sp. Gramen caespitosum, perenne, 30-45 cm. altum; culmi graciles, rigiduli, erecti, 2-4-nodes; foliorum laminae erectae, superne involuto-subulatae, 4-12 cm. longae, subtus minute scaberulae, vaginis plerumque duplo longiores, summa basin paniculae amplectans; ligula lanceolata, 4-6 mm. longa; panicula diffusa, 8-20 cm. longa, ramis capillaribus, verticillatis, divisis, scaberulis, pedicellis, 3-6 mm. longis, distantibus; glumae exteriores inaequales, acutae, divergentes, secus carinam scaberulae, prima 3 mm. longa, secunda 2½ mm. longa; gluma florens 1¾ mm. longa,.glabra, truncata, apice denticulata, 4-5-nervis, mutica; palea paululo brevior; rhachilla in setam glabram vel parce pilosam dimidio vel minus quam palea breviorem producta, ceteroqui nuda; caryopsis conico-oblonga, 1½ mm. longa.

Near Riverton, March, 1931. According to the collector, Mr. Worsley Johnston, it grows in tussocks inside the railway fence. This might suggest an introduced alien, but the railway reserves also serve as sanctuaries for native plants.

Although this species has the rhachilla produced in a small bristle behind the palea, it seems, from the absence of hairs at the base of the flowering glume, to be better placed in *Agrostis* than in *Calamagrostis*. It differs from *C. aequata* in the following characters: stiff stems and involute, not flat leaves, outer glumes about twice as long and much longer than the flowering glume, which has no tuft of hairs at its base. From the Mediterranean *Agrostis maritima*, Lamk. it differs in the long loose panicle, longer pedicels, palea scarcely shorter than the flowering glume and the bristle at its back. (Fig. 5.)

**Schismus barbatus* (L.) Juel, Hort. Linn. 13 (1913) instead of *S. calycinus* (Loefl.) Coss. et Dur. The name *Festuca barbata*, L. (1756) is two years earlier than that of Loefling.

**Sphenopus divaricatus*. Bute; previously recorded from Port Adelaide.

Eragrostis Brownii, Nees. William Creek and Irrapatana (Far North); coll. J. B. Cleland. These northern specimens have the spikelets at first green or purplish, finally straw-coloured, 5-10 mm. long by 2 mm. broad, 10-20-flowered, rarely more. They resemble *E. setifolia*, but the spikelets are sessile or almost so, and the base of the stem is neither bulbous nor woolly.

Deschampsia caespitosa (L.) Beauv. var. *macrantha*, Hackel. On wet rocks beside waterfall on Upper Hindmarsh River; coll. J. B. Cleland. Hitherto only recorded (in South Australia) from the South-East. Differs from the typical European form by the involute-subulate, not flat leaves, and by the longer outer glumes—4½-5 mm. instead of 3 mm. long. These characters seem to occur also in the East-Australian and New Zealand plant, and justify the varietal name which Cheeseman states was given to it by Hackel.

In the Fl. Cap. 7: 587 (1900) Dr. Stapf says that *Sporobolus elongatus*, R. Br. (*S. indicus*, R. Br. var. *elongatus*, Bailey) is a diandrous species distinct from *S. indicus* and extending from Australia to Japan. In a specimen from the Finke River, C.A., with panicles to 25 cm. long and much interrupted, I found, however, out of 14 spikelets examined, 10 flowers with 3 stamens, 2 with 2 stamens, and 2 with 1 stamen each.

**Ehrharta calycina*, Sm. Established on light sandy land at Cockatoo Valley, Barossa Goldfields; Aug., 1931; per A. J. Warren, Department of Agriculture. Native of South Africa. Like all *Ehrhartas*, a good fodder grass.

CYPERACEAE.

Cladium Gunnii, Hook. f. was found in 1930 by Prof. J. B. Cleland at Cleland's Gully, Square Waterhole.

Schoenus tesquorum, J. M. Black. Back Valley, near Encounter Bay; coll J. B. Cleland. Hitherto only recorded from the South-East.

CHENOPODIACEAE.

Atriplex crassipes, J. M. Black (1918). Mr. R. H. Anderson, in Proc. Linn. Soc. N.S.W. 55: 5: 494 (1930) considers that this should be retained as a distinct species, instead of being united to *A. elachophyllum*, F. v. M. (1869). An examination of the type of the latter species shows that there are almost always 3 small protuberances or tooth-like appendages on one or both faces of the fruiting bracteoles. These teeth are lacking in *A. crassipes*. *A. elachophyllum* = *A. varium*, Ewart et Davies (1917) from Central Australia.

A. acutibracteum, R. H. Anderson, l.c. 500. A new species created for the form of *A. leptocarpum* var. *acuminatum*, which I described in Fl. S. Aust. as having "2 small hard dorsal tubercles at the base of the fruiting bracteoles."—Murray Flats; Ooldea; Hughes.

PAPAVERACEAE.

*_Roemeria hybrida_ (L.) DC. Growing wild near Riverton; coll. Worsley C. Johnston. Mediterranean region. Not hitherto recorded.

CRUCIFERAE.

Cardamine tenuifolia, Hook. Nonning, E.P.; coll. R. H. Pulleine. An entirely new district for this species, hitherto found only in the South-East.

Hutchinsia eremaea, J. M. Black. Wangianna, north of Marree, Aug., 1931, coll. J. B. Cleland. These are much better specimens than those on which the species was founded in these Trans. 47:369 (1923). Stems ascending, about 25 cm. high; leaves 1½-3 cm. long, including the petiole into which they taper; sepals about 3 mm. long; petals 5-6 mm. long, with a bright yellow, almost orbicular, lamina; stamens 6, with anthers 1½ mm. long; pods from almost orbicular to ovate and sometimes only 5 mm. long; style exserted beyond the pod to a length of 1½ mm.; cotyledons strictly incumbent.

*_Sisymbrium Irio,_ L. "London Rocket." Near railway station of Owen, Oct., 1931, coll. Worsley C. Johnston. First record for South Australia.

LEGUMINOSAE.

Pultenaea quadricolor, n. sp. Fruticulus erectus, gracilis, ramosus, 20-30 cm. altus, ramis pubescentibus; folia alterna, oblanceolata vel superiora lineari-lanceolata, uninervia, 6-14 mm. longa, 1½-2 mm. lata, infra puberula, supra glabra et marginibus incurvis concava, apice in mucronem recurvum desinentia; stipulae subulatae, 2 mm. longae, petiolum brevissimum superantes; flores axillares, solitarii; pedicelli filiformes, 6-7 mm. longi sed foliis breviores; bracteolae herbaceae, lineares, basi duobus lobulis stipuliformibus instructae, sub imo calyce insertae, calycem aequantes vel paulo superantes; calyx 4-5 mm. longus, parce puberulus, lobis lanceolatis tubo paulo longioribus, duobus superioribus breviter coalitis; vexillum calyce duplo longius, flavum, in medio rubrum, alas flavas carinamque coccineam paulo superans; ovarium pubescens, biovulatum; legumen ignotum.

Back Valley, near Encounter Bay; coll. J. B. Cleland, Nov., 1930. The specific name refers to the green of the leaves, the red and yellow of the standard, the yellow of the wings and the crimson of the keel. Section _Coelophyllum._ Differs from _P. elliptica,_ Sm. in the broader leaves, flowers all axillary and bracteoles much longer; from _P. villifera,_ Sieb. var. _glabrescens_ and _P. trinervis_ in the fewer and less conspicuous nerves of the leaves and in the flowers on rather long pedicels, not almost sessile. (Fig. 8.)

*_Alhagi camelorum,_ Fisch. "Camel Thorn." This spiny, deep-rooted perennial was sent from cultivated land near Jamestown to the Agricultural Department. Said to occur also in water-channels at Berri. Recorded from Rutherglen, Victoria, in 1919. Its native country extends from Southern Russia to North-western India.

*_Trifolium lappaceum,_ L. Echunga.—Mediterranean region.

ZYGOPHYLLACEAE.

Specimens of _Zygophyllum ammophilum,_ from between Coward Springs and Edward Creek, have the capsule only 3 mm. long, with 1 seed in each cell, 4 stamens and petals minute and obovate.

Rutaceae.

Phebalium brachyphyllum, Benth. Sherlock (Pinnaroo railway) and Warooka, Y.P., 1930. This dwarf shrub had remained undetected since the original specimens were collected at Encounter Bay and Coffin Bay over 70 years ago.

Euphorbiaceae.

**Chrozophora tinctoria* (L.) Juss. A weed at Appila. An annual of the Mediterranean region, sometimes cultivated for the blue dye which it yields.

Frankeniaceae.

Frankenia annua, Summerh. in Journ. Linn. Soc. 48: 379, t. 17 (1930) var. *orthotricha*, n. var. Variat pilis patentibus, interdum leviter curvis sed nunquam uncinatis, caulibus pilosioribus et petalis paulo latioribus (4-5 mm. latis).

Diamantina River, S.A., May, 1931; coll. L. Reese.

Umbelliferae.

Eryngium supinum (F. v. M.) n. comb. Caules prostrati, rigidi, costati, fistulati, simplices vel parce ramosi; foliorum laminae flaccidae, cuneatae, complicatae, acute trilobae, 1-2 cm. longae, 3-6 mm. latae, reticulato-nervosae; petiolus 3-6 cm. longus, fistulatus et parce septatus, basi dilatatus; capitula axillaria et radicalia, brevissime pedunculata, adulta oblongo-cylindrata, 12-17 mm. longa, 8 mm. diam.; involucri bracteae 5-8, lineari-lanceolata, 7-8 mm. longa, fere pungentia; petalorum apex inflexus, fimbriatus; receptaculi squamae conico-acuminatae; mericarpium apud commissuram rotundatum; vittae 5, duae commissurales approximatae.—*E. plantagineum*, F. v. M. var. *supinum*, F. v. M. in herb.

S. Aust.—Diamantina River, coll. Dr. Morgan; near Innamincka, coll. R. Cockburn.

Qld.—Wills Creek. Dr. Murray, of Howitt's Expedition.

Differs from *E. rostratum* and *E. plantagineum* in its prostrate habit and very short peduncles; from *E. vesiculosum* in its rigid stems, 3-lobed, not many-toothed leaves, and shorter peduncles, the radical heads being practically sessile. (Fig. 6.)

It has been stated, apparently in all Australian floras (my own of South Australia included), that our species of *Eryngium* have no vittas. All our local species have 5 vittas. The mericarps of Australian *Eryngia* are orbicular in transverse section and have a narrow commissure, so that the two commissural vittas are close together; in European species the mericarp, when cut across, is almost triangular, with a very broad commissure, so that the two commissural vittas are far apart.

**Bupleurum subovatum*, Link (1818) has appeared at the Grange, near Adelaide; a new record.—Mediterranean region. More usually known as *B. protractum*, Hoffmannsegg et Link (1820).

Ericaceae.

**Erica arborea*, L. Roadside, near Aldgate. Flowering Oct., 1931; coll. J. B. Cleland. This is the "White Heath" or "Tree Heath" of gardeners, the "bruyère arborescente" of the French, from whose root "briar pipes" are made. Mediterranean region. Recorded as an escape in Victoria.

Epacridaceae.

Leucopogon collinus (Labill.) R. Br. Bangham Forest Reserve, near Frances; 1930; coll. J. B. Cleland.

BORRAGINACEAE.

Embadium, n. gen.

(From Greek *embadion*, a little slipper, to which the nutlets bear some resemblance.)

Calyx 5-sectus; corolla 5-loba, inappendiculata; stamina 5, inclusa; stylus inter 4 lobos ovarii insertus, stigmate capitato; nuculae 4, suberectae, ovatae vel fere triangulares, superne liberae et stylum multo superantes, dorso margine tumido inflexo crenulato circumdatae, cum parvâ gibbâ oblongâ tumida medianâ semen tegente; nuculae interne convexae, pilis minutis uncinatis conspersae, areolâ medianâ ad gynobasin pyramidalem affixae, ab areolâ usque ad apicem partis seminiferae carinatae. Herba annua; pedicelli fructiferi recurvi.

Embadium stagnense, n. sp. Herba annua, pilis appressis e tuberculis ortis scabrida; caules rigiduli, ascendentes, 5-12 cm. longi, parce ramosa; folia radicalia rosulata, 1-2 cm. longa, longe petiolata, caulina rigidula, sessilia, distantia, oblonga vel lanceolato-ovata, 5-15 mm. longa, in bracteas florales transeuntia; pedicelli fructiferi valde recurvi, 4-8 mm. longi; calycis segmenta lanceolato-ovata, 2 mm. longa, sub fructu patentia; corolla 2½ mm. longa, sine squamis in faucibus, lobis tubo brevioribus; nuculae paululo infra medium parvâ areolâ ad gynobasin affixae.

On recently flooded land at Arcoona, west of Lake Torrens, Sept., 1927; coll. Miss Beatrice Murray. (Fig. 7.) Mr. Ivan M. Johnston, of the Gray Herbarium, Harvard University, and a specialist on *Borraginaceae*, considers that although this little plant approaches *Eritrichium* in the attachment of the nutlets to the receptacle or gynobase, it has other peculiarities which necessitate the creation of a new genus. After examining a specimen which was forwarded to him, he writes:—"The tumid margin combined with the medial crest of the nutlets is unique in the family. Such excessive developments of nutlet margins are usually found in the *Cynoglosseae*. The uncinate pubescence on the fruit is quite characteristic of that tribe also. In fact, I might say that in every *positive* character, except nutlet attachment, it fits into that tribe best, and close to *Omphalodes*. I have, on various occasions stated that I believe that the strict and sole use of nutlet attachments in defining the tribes of the Borages leads to unnaturalness in classification. I am inclined to believe that your plant is a case in point, and that although its technical characters may place it near *Hackelia* and *Eritrichium*, in all probability its nearest relationships are in *Omphalodes*. If this is the case, your plant is a curious Australian development of the *Cynoglosseae* springing from the same immediate stock as has *Omphalodes*, but which, although developing curious marginal structures, has persisted in a primitive attachment of its nutlets."

SCROPHULARIACEAE.

Limosella Curdieana, F. v. M. Beresford (between Marree and Oodnadatta). Flowering and fruiting Aug., 1931; coll. J. B. Cleland. A much more northerly site than any yet recorded.

LABIATAE.

Prostanthera aspalathoides, A. Cunn. Nonning, E.P.; coll. R. H. Pulleine. A new district for this species. Leaves 4-14 mm. long; calyx 12 mm. long, purplish.

Salvia lanigera, Poir. (1817). Netherton, near Tailem Bend. An almost woolly weed not hitherto recorded. Southern Italy, Spain, North Africa, Syria. A synonym is *S. controversa*, Ten. (1830).

COMPOSITAE.

Myriocephalus rhizocephalus (DC.) Benth. var. *pluriflorus*, J. M. Black. Beresford (between Marree and Oodnadatta); coll. J. B. Cleland. A more

northerly site than any previously recorded. The uppermost leaves are sometimes no longer than the general involucre.

**Matricaria multiflora* (Thunb.) Fenzl. First record of this rather showy South African annual, which has established itself over a considerable area near Calomba, a railway station about 7 miles north-west of Mallala. It has numerous small bright-yellow homogamous-discoid heads arranged in dense corymbs.

Minuria rigida. Leaves sometimes nearly all opposite, and the plant may be not more than 8 cm. high. Diamantina River, S.A.; coll. A. M. Morgan.

DESCRIPTION OF PLATE VI.

Fig. 1. *Eragrostis japonica: a,* spikelet; *b,* flowering glume and palea; *c,* grain.

Fig. 2. *E. confertiflora: d,* leaf and ligule; *e,* spikelet; *f,* flowering glume and palea; *g,* grain.

Fig. 3. *E. Kennedyae: h,* spikelet; *i,* flowering glume and palea; *j,* grain.

Fig. 4. *E. infecunda: k,* spikelet; *l,* pistil; *m,* base of stem.

Fig. 5. *Agrostis limitanea: n,* spikelet; *o,* flowering glume and palea; *p,* abaxial face of grain, showing small embryo; *q,* adaxial face, showing longitudinal groove.

Fig. 6. *Eryngium supinum: r,* flower; *s,* petal; *t,* cross section of ripe mericarp; *u,* blade of leaf.

Fig. 7. *Embadium stagnense: v,* outer or dorsal face of nutlet; *w,* inner or ventral face; *x,* tubercle-seated hair.

Fig. 8. *Pultenaea quadricolor: y,* flower; *z,* leaf.

POLLINATION OF CALADENIA DEFORMIS, R. Br.

By R. S. Rogers, M.A., M.D., F.L.S.

[Read October 8, 1931.]

It is a singular fact, that although considerable attention has been directed to the pollination of Australian orchids, very few observations have been recorded in regard to the large and conspicuous genus *Caladenia*.

By far the most important paper that has yet appeared is that of Oswald H. Sargent[1] on the "Pollination of *C. Barbarossae*," Rchb. f., a Western Australian plant, in 1907.

In his great and well-known work,[2] Fitzgerald makes three brief and rather unconvincing contributions to the subject.

In the first of these, when describing *C. dimorpha*, he states: "This is the only species of orchid I have known, when placed in a room, to be fertilized by insects. A house-fly, lighting on the lip, was carried by its spring against the column and, becoming entangled in the gluten of the stigma, and struggling to escape, removed the pollen in its masses from the anther and smeared them on the stigma. Such rather large insects are, I believe, the principal agents of fertilization in the genus, the species of which without such agency, never produce seed."

His next reference is to *C. tesselata*, Fitzg.: "On examination of the plant as it grew, the pollen was found to be drawn out of the anther and attached to the centre of the stigma by a little group of chaffy scales of some plant, which helped to form a cocoon. This cocoon belonged to a dipterous insect, and the flower must have been fertilized by the efforts of the inmate to get rid of its covering. A method of fertilization that may frequently occur, as the dorsal sepal presents a suitable shelter for an insect about to undergo a change, but a method that would hardly be conjectured if not observed."

His third observation is as follows: "On one occasion I had the pleasure of seeing *C. alba* actually fertilized by an insect. A flower was observed to tremble and, on examination, it was found that a fly had alighted upon its labellum, and was by its spring carried against the stigma and, adhering to it, struggled violently to escape, and thereby withdrew the pollen-masses from the anther and smeared them on the stigma. This instance, in my opinion, goes far to show that though the pollinia in this and many other species may, without fertilizing the flower, be easily removed by touching the discs, the operation is not by any means so neatly performed by an entrapped insect, and the consequence is that the flowers are impregnated by their own pollen."

While admitting that pollination may possibly have been effected in the manner described, it is suggested that such instances are of a fortuitous or accidental nature and lack the purposive character which usually marks the act of pollination in orchids under normal conditions. This act is often intricate and, as far as our experience goes, never clumsily performed. The mechanism involved is beautifully adapted for its intended purpose, and wherever successfully investigated has proved to be unencumbered by superfluous or unessential parts. It frequently happens that some minute structural detail, apparently too trivial to claim the attention of the observer, ultimately proved an important factor in the process.

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(1) "Journ. Nat. Hist. Soc. of W.A.," No. 4 (1907), p. 6.

(2) "Australian Orchids."

More or less complicated structures are present in the three species of orchid to which Fitzgerald refers. That they perform some definite function in the normal pollination of the plant there can be no doubt—a function which remains unexplained and valueless in the instances recorded by him.

The patient and careful observations of Sargent form a much more valuable contribution to the literature of the subject. They are confined to the investigation of a single species endemic to his State, and they extended over a period of two or three years. He furnishes satisfactory evidence that this orchid, which is remarkably distinctive in structure, is pollinated by an unidentified wasp. Whether this is the sole agent is, of course, uncertain.

Mrs. Edith Coleman[3] recently reported that on two occasions she had seen this particular orchid visited by a small bee resembling *Halictus*, sp. No pollen was removed on either occasion, but the movements of the insect led her to suspect that it might be an active agent in the fertilization of the plant.

Early in August, of the present year, Mr. Harold Goldsack, of Coromandel Valley, informed me that he had seen a small native bee crawling on the labellum of *Caladenia deformis*, an orchid well represented in this locality. As the bee had several pollinia adhering to its back, he collected it, as well as the plant, and took them home for further observation. The following morning, on opening the box in which it was confined, he found the insect wedged tightly in the tubular space formed between the column and labellum of the orchid. When disturbed it hurriedly backed out on to the free extremity of the lip. During this movement the pollinia were rubbed hard against the stigma, but no further masses were removed from the anther. Later it returned to "its repast," and it was possible to follow its subsequent movements more carefully. It was able, without any exertion, to penetrate the space referred to, until a point was reached when the mesothorax was on a level with the stigma. Then, in its effort to reach the calli at the base of the labellum, it pushed the latter away from the column, at the same time exerting strong pressure with its back against this structure and incidentally pressing the pollen on to the stigma. This movement enabled it to lever the labellum further outwards, and so penetrate a little lower into the tube. The calli were then apparently seized with its fore-legs and the tongue of the insect was protruded, but further observations were, unfortunately, prevented owing to the structure of the flower.

The bee was dead when the specimens reached me by post, the wings were raised and more or less parallel to each other. On the dorsum of the thorax, lying nearly transversely across the insertions of the wings, were two pollinia, and probably a portion of a third. Examination of the anther of the flower showed that the cells were intact and still contained their normal complement of pollen-masses, two in each cell. The stigma was thoroughly dusted with pollen, and an almost entire pollinium was adherent to it. The condition of the anther made it manifest that the masses attached to the insect were derived from another flower. Towards the close of August we made an inspection of many of these plants in the National Park. The day was dull and cloudy, and although not very cold was unfavourable for our investigation. I discovered a specimen of the bee in question crawling up the ovary of a flower. The flower was collected and the subsequent movements of the insect watched. As in the case of Mr. Goldsack's bee, it carried two pollen lamellae attached exactly in the same manner to the dorsum of its thorax. It crawled on to the recurved tip of the labellum and then on to the dense, shaggy calli, where it found a firm footing. It purposively pursued its way into the tube formed by the column and labellum, with its back to the former. It was able to enter this space without coming into contact with the anther or

(3) "Vict. Nat.," xlvi., 1930, p. 204.

pollinia, and penetrated the space deeply until only the tip of its abdomen was visible at the orifice. It then exerted hard and persistent pressure with its feet against the labellum, as though endeavouring to push the latter away from it. The results of this pressure were plainly visible to us in the movements of the labellum causing a widening of the "space" and pressure of the thorax of the insect against the stigma. It was not possible to observe exactly what took place at the base of the column. After a short interval the insect emerged by backing out, and was captured. It still had a couple of pollen lamellae attached to its thorax, but apparently not the same ones, as two masses had been removed from the anther of the flower and pollinia had been successfully deposited on the stigma.

A little later in the day my wife discovered another bee with pollinia adherent as in previous cases. Unfortunately, a capture was not effected in this instance.

On September 2 my wife and I again visited the Park. The day was again unsuitable for our quest, rather cold and rain threatening. Only a single *Halictus* was seen, towards the close of the afternoon. Lamellae were adherent in the usual manner. As the light was beginning to fade, the insect was captured and placed in a container with the flower on which it was found. The following morning it was found *within* the flower. It liberated itself as previous bees had done, but emerged without pollinia on its body. Again the flower was pollinated, but the contents of the anther were intact. Possibly the flower was no longer fresh and, in consequence, removal of the masses had not been accomplished.

Another flower, stripped of its perianth, was introduced into the bottle, but a successful entry was not made.

Caladenia deformis is a very common orchid and is distributed throughout the entire breadth of Southern Australia. It also extends north along the east coast as far as latitude 33°.

It this State it is the first *Caladenia* to appear during the season. A few isolated specimens may be seen during the last few days of July, but it becomes fairly prolific during the early part of August.

The flowers are solitary, deep blue in colour, but occasionally an albino may be seen. The segments of the perianth are spreading, with the exception of the dorsal sepal which is usually more or less hoodlike behind the column. The labellum is not attached by the usual mobile claw, but is rather rigidly erect against the column, the sides of which it clasps, thus forming a tube; the apical part is triangular with fimbriated or dentate margins, and recurved so that its tip is in contact with the anterior surface of the vertical portion, thus facilitating access of the pollinating agent to the tube. Except for a small nude glandular area at the extreme tip, the recurved portion is covered with dense, shaggy calli arranged in six rows; behind these and within the mouth of the tube the calli are smaller, less crowded and reduced to four rows, while towards the base of the lamina there is an area of densely packed, large, colourless, glandular-looking calli covered with stellate hairs. When the labellum is in its normal position these large calli are in close contact with the anterior surface of the lower half of the column, thus preventing further ingress of an insect, unless force is exerted by the latter to displace the labellum outwards. These basal calli are apparently the tissues sought by the bee, and it is during its efforts to reach them that its thorax is pressed against the stigma and pollination is thus effected.

The column is about 1·3 cm. long, erect in its lower part and rather abruptly incurved near the apex. It is winged throughout, the wings being much wider on either side of the stigma, thus limiting lateral movement of the agent and ensuring direct contact with the stigmatic surface. It is blue or purplish in tint with darker dots or transverse markings, especially on the wings.

The anther is attached almost horizontally to the summit, its mucrone being rather long and acute. It is bilocular, each cell being subdivided by a vertical dissepiment and containing a pair of free pollinia. Each pollinium consists of a flat, rather bluntly falcate lamella composed of dry, mealy pollen. It is wider at the base than at the apex, and has a convex anterior margin. As the anther matures, its valves slightly retract by curling backwards, thus exposing the convex margins of the pollinia a little above the rudimentary rostellum, the surface of which is *very viscid.* The pollinia are devoid of caudicles and viscid disc.

Immediately below the anther is the funnel-shaped stigma, which like the rostellum is extremely viscid. The pollinia are easily withdrawn when any of this sticky material is brought in contact with their exposed edges.

No nectar is secreted by the flower. The base of the labellum and its adjacent parts are quite dry, and no injury to any of these parts can be detected after the act of pollination. The actual source of attraction to the insect is not apparent. It is noticeable, however, that a positive glucose reaction is yielded by the column and to a lesser extent by the labellum.

The bee was subsequently identified as *Halictus subinclinans,* Ckll., by Mr. Tarlton Rayment, the well-known expert in this group. It is smaller than a house-fly and is admirably adapted, both in shape and size, to perform the service which it renders to this particular *Caladenia.*

In his letter to our Museum staff, Mr. Rayment briefly outlines its life-history, which is of extreme interest and forms one of the romances of science.

Inter alia he states that the first females emerge early in August, but he has never been able to secure any males. He has reason to suppose that the males only appear in the late autumn.

Their homes are in well-drained sandy banks, the shafts have a diameter of two or three millimetres and go down almost vertically.

PELECYPODA FROM THE ABATTOIRS BORE, INCLUDING TWELVE NEW SPECIES.

By Nelly Hooper Woods, M.A.

[Read October 8, 1931.]

Plates VII. and VIII.

Introduction.

The shells of which those cited in this paper form a part were collected by Sir Joseph Verco after the sinking of the Abattoirs Bore in 1919. Unfortunately, the material had been heaped beside the bore before any opportunity could be gained of ascertaining the depth from which the various fossils were obtained. It is impossible, therefore, to assign new species to any definite horizon; one can only remark that the fossils were taken from a depth between 400 and 500 feet, and are probably of Janjukian to Werrikooian age.

It has been interesting to compare many of the fossil species with the recent shells, and to observe in some cases gradations between the fossil and the recent. This is so in the case of *Nuculana crebrecostata* T. Woods and *Nuculana verconis* Verco; specimens intermediate between the two were found. In the case of *Limopsis beaumariensis* Chapman, the juvenile shells bear a marked resemblance to *Limopsis eucosmus* Verco.

Many thanks are due to Mr. F. Chapman for his assistance with difficult and new species.

Nucula venusta, n. sp.

(Pl. vii., figs. 1 and 2.)

Solid, ventricose, inequilateral, ovate; umbo very prominent, inclined markedly to posterior; posterior margin short, curved evenly from dorsal to ventral border; anterior margin longer than posterior, curving evenly though slightly more sharply from dorsal to ventral border.

Interior of shell smooth, nacreous, ventral margin flattened, without denticulations; surface smooth, shining, with fine concentric growth-lines of varying strength.

Cardinal line with 17 teeth anteriorly, slightly uncinate, and 6 posteriorly; teeth strong, high.

Length, 5·6 mm.; height, 4·8 mm.

Observations.—Unfortunately there are only two right valves of this beautiful little shell, which, though resembling it in some respects, differs markedly from *N. obliqua* Lamarck. The shell is much more tumid, especially in the umbonal region; it is more produced anteriorly, and has fewer teeth. The junction between the anterior and posterior row is worn in both specimens, making it impossible to tell the nature of the resilifer.

Rochefortia macer, n. sp.

(Pl. vii., fig. 3.)

Thin, white, medium, somewhat flattened, inequilateral, posterior side longer than anterior and more sharply produced; anterior margin roundly curving to ventral border; interior of shell smooth, ventral border without denticulations; surface smooth, shining, with fine concentric striae of varying prominence. Hinge

with one strong cardinal tooth inclined posteriorly and one small, more depressed tooth inclined anteriorly.

Length, 11·1 mm.; height, 9·3 mm.

Rochefortia tellinoides, n. sp.

(Pl. vii., fig. 4.)

Small, thin, moderately convex, inequilateral; posterior margin slightly more sharply curving than anterior; umbones small, situated anteriorly. Hinge line without dentition, consisting of two small plates on either side of the umbo, leaving a space beneath the umbo.

Shell longer than high; interior smooth; adductor impressions and pallial line distinct; surface ornamented with fine concentric striae.

Length, 5·7 mm.; height, 3·6 mm.

Dosinia grandis, n. sp.

(Pl. vii., figs. 5 and 6.)

Large, thick, solid, several thick layers being revealed when the shell is broken; area inside pallial line thicker than that outside (this may possibly be due to weathering of specimens); outline of shell indefinite, as the shells have been broken in taking them from the bore; hinge plate very heavy, bearing in the right valve two strong, high cardinal teeth and a deep depression for the insertion of a large tooth of the left valve, and from the umbo to the posterior edge a subtriangular depressed area followed by a triangular area for the ligament and a deep and narrow sulcus; lunule deeply situated; adductor impressions deep and clear. Sculpture consists of numerous thin, fine concentric striae.

Measurements cannot be accurately determined owing to fragmentary nature of specimens, but approximate to:—

Length, 70 mm.; height, 70 mm.

Gafrarium perornatum, n. sp.

(Pl. vii., figs. 7 and 8.)

Medium to small, solid, ovate, longer than high, posterior side produced somewhat; umbones high, acute, situated in front of the middle axis of the shell; both posterior and anterior borders roundly curving to the ventral margin.

Interior smooth, pallial sinus distinct. Surface of shell ornamented with numerous regular radial striae which, on certain umbo-ventral lines, are crossed by short oblique striae making V-shaped patterns, pointing both ventrally and dorsally. Also occasional and varying concentric striae of growth.

Type: Length, 9·6 mm.; height, 7·5 mm.

Larger specimen: Length, 13·5 mm.; height, 10·8 mm.

Antigona pernitida, n. sp.

(Pl. viii., figs. 1 and 2.)

Small to medium, sub-ovate, lengthened anterior-posteriorly; umbones prominent and acute, situated to the anterior side of the central axis; anterior margin roundly curving to the ventral border; posterior margin longer than anterior, curving sharply to ventral edge.

Shell moderately inflated, interior finely crenulate; surface closely ornamented with regular growth lines, the interspaces of which are crossed by fine radial costae.

The type is a small, neat shell which seems to differ from *A. dennanti* Chap. and Crespin in the greater number and prominence of its concentric growth lines, and the greater length of the valve in relation to its height.

A fragment of a larger shell of the same species also came up from the bore, dimensions being about twice those of the type.

Length, 12·3 mm.; height, 9·4 mm.

Pseudoarcopagia detrita, n. sp.

(Pl. vii., fig. 9.)

Small, solid, trigonal, moderately convex, particularly in the umbonal area; anterior side slightly longer and more rounded than posterior.

Interior of shell smooth, ventral border without crenulations; pallial line indistinct owing to the weathering of specimens. In right valve two cardinal teeth, and one lamellar tooth on anterior side—deep socket on posterior; in left valve two cardinal teeth fitting into corresponding sockets of right valve; one large posterior lateral tooth and two anterior laterals fitting into sockets of right valve.

Exterior of shell sculptured with numerous fine radial striae bifurcating towards the ventral border.

Length, 4·8 mm.; height, 4·2 mm.

Diplodonta solitaria, n. sp.

(Pl. viii., fig. 3.)

Holotype—one rather worn specimen only of left valve.

Orbicular, subequilateral, moderately convex; ligament groove long, narrow; umbo subcentral, slightly incurved; lunule lanceolate, slightly sunken. Valve with three cardinal teeth, one bifid; pallial line punctate marked; ventral margin rounded, smooth. Sculpture—fine concentric lines of growth with occasional broader lines.

Length, 22·8 mm.; height, 21·7 mm.

Codakia salebrosa, n. sp.

(Pl. viii., figs. 4 and 5.)

Very thick, rude, interior inside pallial line covered frequently with thick concretions; inequilateral, equivalve, sharply curving on anterior margin, semicircular on posterior side. Ligament pit internal, long, deepening from umbo to top of posterior border; umbones acuminate, teeth embryonic or obsolete. Ventral margin without crenulations. Shell surface very rough with numerous concentric growth lines of varying prominence, crowded near the border.

Length, 27·5 mm.; height, 26·7 mm.

Cryptodon sinuatum, n. sp.

(Pl. viii., Fig. 6.)

Medium to small, thin, triangular-ovate, inequilateral, very swollen, particularly in the dorsal region; umbones prominent, high, placed a little in front of the central axis. Anterior border curved, lower half coming almost at right angles to the ventral margin, posterior part of shell with deep fold. Interior of valve smooth; ventral margin sharp, without crenulations; surface of shell with fine concentric striae of growth in varying prominence.

Holotype: One left valve only. Length, 8·1 mm.; height, 8·2 mm.

Solecurtus subrectangularis, n. sp.

(Pl. viii., Fig. 7.)

Small, thin, inequilateral, posterior side longer and broader than anterior, oblong, very slightly gaping at both ends; posterior side about $\frac{3}{5}$ of the whole length; posterior dorsal line straight, nearly parallel with ventral margin; anterior dorsal margin inclined to horizontal; anterior margin more rounded than

posterior margin, which is nearly vertical. Umbo small. One strong cardinal tooth beneath the umbo; two lateral sockets in front and behind. Pallial line and adductor impressions indistinct.

Surface of shell rudely sculptured with concentric striae of growth crossed by fine bifurcating radial striae; umbonal area showing buff colour, ventral margin white.

Holotype: Left valve. Length, 7·7 mm.; height, 4·6 mm.

Corbula equivalvis, n. sp.

(Pl. viii., figs. 8 and 9.)

Solid, equivalve, inequilateral, ventricose, ovately-triangular, rounded anteriorly, beaked posteriorly, posterior side longer than anterior. Umbones prominent, incurved, especially in right valve; right valve with sharp teeth situated in anterior; left valve with large flattened tooth in posterior side of shell. Surface of shell sculptured with many fine concentric striae, varying in thickness and often discontinuous, particularly in centre of shell, where in one senile specimen a slight furrow is produced; posterior side carinated from umbo to ventral margin; sculpture behind the carina same as rest of shell. Pallial sinus and adductor impressions distinct.

Type: Length, 14·2 mm.; height, 8·4 mm.

Larger specimen: Length, 16·8 mm.; height, 9·3 mm.

LIST OF PELECYPODS OBTAINED FROM THE BORE.

Order PRIONODESMACEA.

Family NUCULIDAE.

Nucula obliqua *Lamarck*.
Nucula morundiana *Tate*.
Nucula venusta *Hooper Woods*.

Family NUCULANIDAE.

Nuculana woodsii *Tenison Woods*.
Nuculana crebrecostata *T. Woods*.
Nuculana verconis *Verco*.

Family PARALLELODONTIDAE.

Cucullaea corioensis *McCoy*.

Family LIMOPSIDAE.

Limopsis beaumariensis *Chapman*.
Limopsis maccoyi *Chapman*.
Limopsis affinitalis *Chapman*.

Family ARCIDAE.

Lissarca rubricata *Tate*.
Arca navicularis *Tate*.
Arca (Barbatia) pistachia *Lamarck*.
Glycimeris convexa *Tate*.
Glycimeris tenuicostata *Reeve*.

Family PTERIIDAE.

Pinctada crassicardia *Tate*.

Family OSTREIDAE.

Ostrea hyotidoidea *Tate*.

Family TRIGONIIDAE.

Neotrigonia acuticostata *McCoy*.

Family PECTINIDAE.

Pecten consobrinus *Tate*.
Chlamys peroni *Tate*.
Chlamys antiaustralis *Tate*.
Amusium hochstetteri *Zittel*.
Hinnites corioensis *McCoy*.

Family SPONDYLIDAE.

Spondylus arenicola *Tate*.

Family LIMIDAE.

Austrolima bassi *T. Woods* (Lima bassi)

Family ANOMIIDAE.

Monia ione *Grey*.

Family MYTILIDAE.

Trichomya hirsuta *Lamarck* (Brachyodontes hirsutus).

Family THRACIIDAE.

Thraciopsis elongata *May*.

Family MYOCHAMIDAE.

Myodora ovata *Reeve*.
Myodora tenuilirata *Tate*.
Myodora corrugata *Tate*.

Family CLAVELLIDAE.

Humphreyia strangei *Adams* and *Angas*.

Family CUSPIDARIIDAE.

Cuspidaria subrostrata *Tate*.

Order TELEODESMACEA.

Family CRASSITELLITIDAE.

Crassitellites oblonga *T. Woods.*
Cuna polita *Tate.*

Family CARDITIDAE.

Cardita compta *Tate.*
Cardita preissi *Minke.*
Venericardia spinulosa *Tate.*
Venericardia pecten *Tate.*
Venericardia subcompacta *Chapman* and *Crespin.*

Family CHAMIDAE.

Chama lamellifera *T. Woods.*

Family LUCINIDAE.

Lucina leucomorpha *Tate.*
Lucina affinis *Tate.*
Lucina projecta *Tate.*
Lucina nuciformis *Tate.*
Lucina fabuloides *Tate.*
Loripes icterica *Reeve.*
Codakia salebrosa *H. Woods.*
Divaricella quadrisulcata *D'Orbigny.*

Family DIPLODONTIDATE.

Diplodonta solitaria *H. Woods.*

Family CRYPTODONTIDAE.

Cryptodon sinuatum *H. Woods.*

Family LEPTONIDAE.

Lepton trigonale *Tate.*
Lepton crassum *Tate.*
Erycina micans *Tate.*
Montacuta sericia *Tate.*
Rochefortia anomala *Angas.*
Rochefortia donaciformis *Angas.*
Rochefortia ovalis *Tate.*
Rochefortia macer *H. Woods.*
Rochefortia tellinoides *H. Woods.*

Family GALEOMMIDAE.

Sportella jubata *Hedley.*

Family CARDIIDAE.

Cardium cygnorum *Deshayes.*
Cardium hemimeris *Tate.*

Family VENERIDAE.

Dosinia johnstoni *Tate.*
Dosinia grandis *H. Woods.*
Gafrarium perornatum *H. Woods.*
Macrocallista submultistriata *Tate.*
Antigona propinqua Tate.
Antigona striatissima *Tate.*
Antigona dimorphylla *Tate.*
Antigona pernitida *H. Woods.*
Clausinella subroborata *Tate.*
Bassina allporti *T. Woods.*
Callanaitis cainozoica *T. Woods.*
Paphia fabagelloides *Tate.*

Family TELLINIDAE.

Psammobia hamiltonensis *Tate.*
Psammobia equalis *Tate.*
Tellina masoni *Tate.*
Pseudoarcopagia detrita *H. Woods.*

Family SEMELIDAE.

Semele vesiculosa *Tate.*

Family SOLENIDAE.

Solecurtus dennanti *Tate.*
Solecurtus subrectangularis *H. Woods.*

Family MACTRIDAE.

Mactra howchiniana *Tate.*
Zenatiopsis angustata *Tate.*

Family CORBULIDAE.

Corbula ephamilla *Tate.*
Corbula equivalvis *H. Woods.*

Family SAXICAVIDAE.

Saxicava australis *Lamarck.*
Saxicava subalata *Gatliff* and *Gabriel.*

EXPLANATION OF PLATES.

PLATE VII.

Fig. 1. Nucula venusta, n. sp. X8.
Fig. 2. N. venusta, n. sp. X8.
Fig. 3. Rochefortia macer, n. sp. X4.
Fig. 4. R. tellinoides, n. sp. X8.
Fig. 5. Dosinia grandis (left valve), n. sp. ⅘ natural size.
Fig. 6. D. grandis (right valve), n. sp. Nearly natural size.
Fig. 7. Gafrarium perornatum, n. sp. X5.
Fig. 8. G. perornatum, n. sp. X5.
Fig. 9. Pseudoarcopagia detrita, n. sp. X9.

PLATE VIII.

Fig. 1. Antigona pernitida, n. sp. X4.
Fig. 2. A. pernitida, n. sp. X4.
Fig. 3. Diplodonta solitaria, n. sp. X2.
Fig. 4. Codakia salebrosa, n. sp. $X^8/_3$.
Fig. 5. C. salebrosa, n. sp. $X^8/_3$.
Fig. 6. Cryptodon sinuatum, n. sp. X5.
Fig. 7. Solecurtus subrectangularis, n. sp. X7.
Fig 8. Corbula equivalvis, n. sp. X3.
Fig. 9. C. equivalvis, n. sp. X3.

AUSTRALIAN FUNGI: NOTES AND DESCRIPTIONS.—No. 8.

By J. Burton Cleland, M.D.

[Read October 8, 1931.]

The last paper of this series, No. 7, appeared in these Transactions and Proceedings, vol. lii., 1928, pp. 217-222. In the present paper, a number of new species of Agarics and Clavarias are described. Colour tints when specifically noted in capital letters are based, unless otherwise stated, on Ridgway's "Colour Standards and Colour Nomenclature," 1912 edition, references to the plates therein being given.

I am much indebted to Miss E. M. Wakefield, of the Royal Botanic Gardens, Kew, England, for kindly examining a number of specimens and water-colour drawings of Australian Clavarias forwarded to the Director, and for comparing these critically with the world-wide collections there and for expressing opinions on these species. Extracts from her report are appended to the descriptions of the species concerned.

499. *Amanita subalbida,* n. sp.—Pileus 1¾ in. (4·4 cm.) in diameter, irregularly convex, then nearly plane with the centre somewhat depressed, mealy with the remains of the universal veil, pallid brownish to nearly white. Gills just adnexed, close, rather narrow, white. Stem 1 in. (2·5 cm.) high, elongating from the bulbous base to 1¾ ins. (4·4 cm.), rather short, ⅜ in. (10 mm.) thick, submealy, nearly equal when expanded, solid, white. Ring superior, when young well marked, membranous, marked above with gill-lines, tending to disappear. Volva disappearing, as a slight friable rim-like edge to the bulb. Spores white, obliquely elliptical, 9·5 × 5·5 μ. Half-buried in sandy soil. S.A.—Kinchina, June 8, 1925.

500. *Amanita conico-bulbosa,* n. sp.—When young 2 ins. (5 cm.) in diameter, plano-convex with a deep rounded border and edge turned in, slightly viscid when moist, finely villose, greyish white; base of the stem very bulbous (1½ in., 3·7 cm. thick), the root conical and 2¼ ins. (5·6 cm.) deep. When adult, pileus 2 to 4 ins. (5 to 10 cm.) in diameter, slightly convex to a little upturned or convex with the centre depressed, slightly viscid when moist, in places smooth and shining, in others subvillose, with scattered warty patches often villose at the base, or the whole surface dull with no flakes, cuticle peels, white with a slight biscuity tint or chalky white, occasionally with a greyish-brown tint. Gills just reaching the stem, attenuated towards it, close, ¼ to ½ in. (6 to 12·5 mm.) deep, ventricose, short ones at the periphery, creamy white, when old with a buffy tint in some lights, when dry brownish. Stem up to 3 to 5 ins. (7·5 to 12·5 cm.) high, ⅞ in. (2·1 cm.) thick, slightly attenuated upwards, gill-marked above, fibrillose-scaly to matt below, solid, white or whitish, bulb 1¼ to 1½ in. (3·1 to 3·7 cm.) thick, root up to 3 ins. (7·5 cm.) long, conical downwards. Ring superior to median, ample, dependant marked with gill-lines above, evanescent. No obvious volva, or volva as a mealy-evanescent rim when young. Flesh white, moderately thick (¼ in., 6 mm., or more), attenuated outwards. Smell sometimes slightly fragrant, when cut somewhat phosphorus-like. Spores elliptical, hyaline, 9 to 11·5 × 5·5 to 7 μ. Partly buried in sand or in the ground. S.A.—Kinchina, Beaumont, June, July, August, October.

This species is characterized by being greyish-white when young, later white with a slight biscuity or greyish-brown tint, and by having, usually, scattered villose warty patches, no strong smell and a very long conical root.

501. *Amanitopsis sublutea,* n. sp.—Pileus 1½ to 1¾ in. (3·7 to 4·3 cm.) broad, convex, becoming depressed a little in the centre, sticky when moist, pale buff [a little deeper than Warm Buff (xv.)]. Gills just reaching the stem, moderately close, becoming slightly ventricose, white. Stem up to 1¾ in. (4·3 cm.) high, ⅜ in. (10 mm.) thick, equal, mealy above, smooth below, white or a little buff-tinted below, bulb up to ¾ in. (19 mm.) thick, spherical, the colour of the pileus, edge just free. Flesh of pileus rather thin, white, attenuated outwards. Spores oblique, 13 to 13·5 × 7 μ. In sand. S.A.—Encounter Bay, August, 1929.

502. *Lepiota fuliginosa,* n. sp.—Pileus up to ⅞ in. (2·2 cm.) in diameter, slightly convex, then plane or a little upturned, in the centre sooty-brown from minute fibrous scales, almost villose, the scales scantier and paler round the periphery, leaving a pallid, slightly sooty zone ⅛ in. (3 mm.) or more in diameter. Gills barely free, narrow, close, creamy white. Stem ⅛ to ¾ in. (3 to 19 mm.) high, short, equal, smooth, solid, pallid whitish. Ring distant, as a narrow membranaceous ring, evanescent. Spores oblique with an apiculus, 5·5 × 4·5 μ. On the ground. S.A.—Kinchina, June 8, 1925.

503. *Lepiota nigro-cinerea,* n. sp.—Pileus ½ in. (1·2 cm.) in diameter, convex, subumbonate, dark grey from floccose scales. Gills barely reaching the stem, moderately close, cream-coloured. Stem ⅝ in. (16 mm.) high, slender, a little fibrillose below, whitish. Ring (?) evanescent. Spores very oblique, sometimes nearly triangular, not thick-walled, 5·5 × 3·5 μ. On the ground. S.A.—Encounter Bay, May 24, 1928.

504. *Lepiota cinnamonea,* n. sp.—Pileus ½ to 1 in. (1·2 to 2·5 cm) in diameter, at first almost campanulato-convex, then expanding to convex, often more or less broadly umbonate, slightly floccose to flecked with minute scales, Light Pinkish Cinnamon (xxix.) to Cinnamon or near Tawny (xv.), sometimes when dry near Apricot Buff (xiv.). Gills just free or barely reaching the stem, rather close to moderately distant, rather narrow, ventricose, cream. Stem 1 in. (2·5 cm.) high, rarely 1½ in. (3·7 cm.), rather slender (5 mm. thick), slightly attenuated upwards, fibrillose to fibrillose-scaly up to the veil attachment which is superior, stuffed or slightly hollow, paler than the pileus to near Tawny, sometimes Cinnamon Rufous (xiv.). No definite ring. Flesh thin, whitish, in the stem with a cinnamon tint and white in the centre. Spores elliptical, slightly oblique, not thick-walled, 5·5 to 7·5 × 3·7 to 4 μ. S.A.—On the ground in a glade in stringy-bark forest, National Park; in *Pinus radiata* Don. *(P. insignis* Douglas) forest, Mount Burr (S.E.), May, 1931.

505. *Lepiota subcristata,* n. sp.—Pileus 1 to 1½ in. (2·5 to 3·7 cm.), at first conico-convex, then convex to nearly plane, with an obtuse umbo, densely covered with small brown fibrillose scales, darker and closer at the disc. Gills free, moderately close, white. Stem to 1¾ in. (4·4 cm.) high, rather slender, stuffed tending to be hollow, shaggy with fibrils up to the veil attachment, smooth above. No definite ring. Spores elliptical, not thick-walled, 5·5 to 3·7 μ. S.A.—In *Pinus radiata* Don. *(P. insignis* Douglas) forest, Mount Burr, May, 1931.

Resembles *L. cristata* (A. and S.) Fr., but differs in the shaggy fibrillose stem without a definite ring. *L. cristata* grew in the same locality.

506. *Lepiota discolorata,* n. sp.—Pileus 1¼ to 2 ins. (3 to 5 cm.) in diameter, nearly plane, a little upturned, subumbonate, covered with dense very dark reddish-brown scales, fewer near the periphery, sometimes slightly striate at the periphery. Gills just free, close, white or cream-coloured. Stem 1¼ to 2½ ins. (3·1 to 6·2 cm.) high, slender, hollow, white above, pale brownish below or pallid with minute brownish flecks. Ring distant, membranaceous, evanescent. Flesh white stained reddish. Smell strong, radishy. The whole plant when dry Fuscous to Fuscous Black (xlvi). Spores elliptical, oblique, not thick-walled, 5 to 6·5 ×

3·5 μ, sometimes 7·5 to 9 × 4·5 μ. On the ground. S.A.—Mount Lofty; National Park; in *Pinus radiata* Don. (*P. insignis* Douglas) forest, Kalangadoo (S.E.). April to June.

A moderately small species, recognised by the dark reddish-brown scales in the pileus and the discolouration of the whole plant on drying.

507. *Lepiota haemorrhagica*, n. sp.—Pileus ¾ to 1¼ in. (1·8 to 3·1 cm.) in diameter, convex, sometimes irregular, covered with reddish-brown fibrillose scales thicker and darker at the disc. Gills free, close, creamy-coloured turning reddish like a fresh bloodstain when bruised. Stem 2 ins. (5 cm.) high, relatively rather stout, attenuated upwards, slightly hollow, clothed with reddish-brown fibrils even above the distant definite membranous pale to reddish ring. Spores elliptical, slightly oblique, not thick-walled, microscopically slightly tinted, 6 × 3·5 μ. On the ground in *Eucalyptus* forest. S.A.—Mount Burr (S.E.), May, 1931.

508. *Lepiota umbonata*, n. sp.—Pileus ½ in. (1·2 cm.) in diameter, slightly convex with a broad obtuse umbo, pallid whitish with a buffy tint. Gills just free, moderately close, pallid flesh-coloured. Stem 1¼ in. (3·1 cm.) high, slender, flesh-coloured. Ring distant. Whole plant when drying brownish. Spores not thick-walled, 5·5 × 3·5 μ. S.A.—In *Pinus radiata* Don. (*P. insignis* Douglas) forest, Kalangadoo, May.

A small species with a whitish umbonate pileus and slender moderately long stem.

509. *Lepiota albo-fibrillosa*, n. sp.—Pure white. Pileus ⅛ in. (3·5 mm.) in diameter, convex, subumbonate, mealy, dotted with white fibrils continuous with the veil and clothing the stem below the attachment of the veil, no definite ring. Gills free, many short, edges rather thick, white. Stem ⅜ in. (10 mm.) high, slender, base a little swollen. Spores elliptical, 6·2 to 7·5 × 3·75 μ. On the ground, under a rock. S.A.—Mount Lofty, May.

A minute white delicate short-stemmed species with white fibrils on the pileus and clothing the stem without a well-defined ring.

510. *Lepiota bulbosa*, n. sp.—Pileus 1 in. (2·5 cm.), convex, pale earthy brown with scattered villose scales. Gills barely reaching the stem, close, slightly ventricose, creamy white. Stem ¾ in. (18 mm.) with the bulb, slender, under ¼ in. (6 mm.) thick, bulb ½ in. (12·5 mm.) thick, white and striate from the gills above the median fixed definite membranous ring, slightly fibrillose and whitish with a brownish tint below, slightly hollow. Spores elliptical, oblique, not thick-walled, 9·3 to 10·5 × 5·5 to 7 μ. On the ground. S.A.—Inman Valley, September 5, 1925.

511. *Clitocybe straminea*, n. sp.—Pileus 1 to 1½ ins. (2·5 to 3·7 cm.) in diameter, irregularly convex, centre usually depressed, thin, nearly semi-translucent, pilose in the centre, fibrillose peripherally, slightly striate, edge radiately splitting, centre blackish-brown, the remainder smoky yellowish-brown, the smokiness due to fine fibrils. Gills slightly but definitely decurrent, moderately close, straw-coloured to pale egg-yellowish. Stem 1½ to 2 ins. (3·7 to 5 cm.) high, equal, slender, somewhat flexuous, twisted, slightly striate, mealy fibrillose above, less so below, hollow, the colour of the gills. Spores subspherical, 4 to 5 μ. Densely caespitose at the base of stumps. S.A.—Mount Lofty, March, April. The specific name has reference to the straw colour of the gills and stem.

512. *Clitocybe eucalyptorum*, n. sp.—Pileus 6 ins. (15 cm.) or more in diameter, irregularly convex with the edge turned in when young, then expanding, the centre finally more or less depressed, repand, innately fibrillose to subtomentose with occasionally small circular patches of thickened cuticle, the edge slightly sulcate, Drab (xlvi.) when young to browner than Tawny Olive (xxix.). Gills moderately decurrent, moderately close, up to ⅜ in. (10 mm.) deep, attenuated at the periphery, cream-coloured, assuming a slight fleshy tint, becoming yellowish

round the edge when old. Stem 4 ins. (10 cm.) long, stout, up to 1 in. (2·5 cm.) thick, swollen below when young, marked above with lines of the gills, subfibrillose below, pallid with tints as on the pileus, with white mycelium mixed with earth at the base. Shed spores subspherical, pear-shaped, slightly irregular, hyaline, 5·5 to 6·5 × 4·5 μ. On the ground amongst leaves, etc., under *Eucalyptus*. S.A.—National Park, July.

513. *Clitocybe campestris,* n. sp.—Pileus up to 1 in. (2·5 cm.) in diameter, slightly convex, irregular with a depressed centre, slightly shiny, the edge turned in when young, pallid stone colour and slightly mottled, faintly obscured by a minute white pile (near Avellaneous, xl.; Light Buff, xv.). Gills adnate, close, rather thick, rarely forking or with buttresses, pallid brownish white (Avellaneous, xl.; near Vinaceous Buff, xl.). Stem up to ¾ in. (1·8 cm.) high, stout, sometimes flattened, slightly fibrous, tough, hollow, mealy, pallid, or the colour of the pileus. Flesh white. Smell strong. Spores 4·5 to 4·8 × 2·2 to 3·2 μ. In grassy places, Beaumont Common, May, June; Eagle-on-the-Hill, June (Miss Fiveash, Watercolour No. 25); Noarlunga Hill (spores 5·5 × 3·7 μ).

A small species somewhat resembling small specimens of *Hebeloma hiemale* Bres., characterised by its pallid buff pileus with darker tints of avellaneous and wood brown appearing as if under the surface, the avellaneous gills, short stem and occurrence in grassy places.

514. *Clitocybe pascua,* n. sp.—Pileus 1 to 1½ in. (2·5 to 3·7 cm.), rarely 2 ins. (5 cm.) in diameter, irregularly convex, soon becoming depressed in the centre and sometimes infundibuliform, edge often irregular and wavy or slightly lobed, sometimes lacerated, smooth, when moist between Sudan Brown and Brussels Brown (iii.) and semi-translucent, when dry opaque whitish or buffy whitish. Gills slightly decurrent, rather close, moderately narrow, many short, greyer than Pinkish Buff (xxix.). Stem short, ½ to 1 in. (1·2 to 2·5 cm.) high, slender, equal or sometimes attenuated downwards, fibrillose, hollow, brownish when moist, pallid when dry. Flesh watery brownish when moist, whitish when dry. Smell a little strong. Spores obliquely elliptical, 7 × 3·7 μ. Gregarious on grassy hills. S.A.—Near Noarlunga, June 25, 1927.

515. *Clitocybe australiana,* n. sp.—Pileus up to 1¼ to 4 ins. (3·1 to 10 cm.) in diameter, irregular, somewhat convex, centre depressed, edge rather irregular and broken up, dull, smooth, pale biscuit colour (near Pinkish Buff, xxix.), paler than Mikado Brown (xxix.) and near Vinaceous Cinnamon (xxix.), soapy-looking when moist, near Sayal Brown (xxix.) when dry. Gills adnato-decurrent to decurrent, narrow, moderately close, near Pinkish Buff. Stem up to 1½ ins. (3·7 cm.) high, slender to stout, up to ⅝ in. (15 mm.) thick, slightly attenuated downwards, dull surface, solid or slightly hollow, with fluffy mycelium at the base, white. Flesh white, thick over the stem, attenuated outwards. Spores 3·2 to 5·6 × 1·6 to 3·2 μ. Single or two or three together or subcaespitose in sandy soil under trees. S.A.—Kinchina, Monarto South, and Enfield. N.S.W.—Bumberry and Manildra. July, August, September, October.

516. *Collybia subdryophila,* n. sp.—Pileus up to 1¼ in. (3·1 cm.), slightly convex, sometimes eventually a little upturned at the edge, irregular, matt, near Pinkish Buff (xxix.). Gills adnate to adnexed (once apparently sinuate), close, narrow, creamy white. Stem up to 1½ in. (3·7 cm.) high, rather slender, sometimes flattened, sometimes slightly attenuated upwards, smooth or matt, hollow, flesh confluent with but heterogeneous from that of the pileus, reddish-brown (near Verona Brown, xxix.). Shed spores with one end more pointed, 4 to 4·2 × 2 μ. S.A.—Mount Lofty, July, 1921, and April, 1924 (spores 5·6 × 3·75 μ); Mount Compass, October; Kinchina, July (spores 3·2 × 2 μ); near Happy Valley, September; National Park; Hope Valley.

517. *Collybia deusta*, n. sp.—Pileus 2 to 3 ins. (5 to 7·5 cm.) in diameter, irregularly plane to slightly depressed with a trace of umbonation, edge somewhat undulatory, surface matt to subtomentose, smoky brownish to scorched brown. Gills adnato-adnexed with occasionally a decurrent tooth, close, narrow (¼ in. +, 6·5 mm. deep), pallid dingy greyish to pallid dingy buff. Stem 1½ to 2 ins. (3·7 to 5 cm.), rather slender (¼ to ⅜ in., 6 to 9 mm., thick), fibrillose, tough, solid, base slightly swollen into a knob ending abruptly, dark smoky brown. Flesh of stem cartilaginous differing in texture from the flesh of the pileus, which is white and thin. Spores elliptical, 8·5 × 5·2 μ. No obvious smell. S.A.—In sand under *Melaleuca halmaturorum* F. v. M., Inman River, Victor Harbour. May.

518. *Collybia alutacea*, n. sp.—Pileus ¾ to 1½ in. (1·8 to 3·7 cm.) in diameter, more or less plane becoming upturned-repand, sometimes subumbonate, smooth, rich salmony-buff and moist-looking, sometimes reddish-brown at the periphery, drying opaque matt and a paler pinkish-buff. Gills adnexed, narrow, close, creamy white. Stem ¾ to 1 in. (1·8 to 2·5 cm.) high, rather short, somewhat slender, sometimes flattened, equal, smooth, slightly hollow, pallid with a slight or definite tint of the pileus. Flesh of the stem cartilaginous differing from the thin white flesh of the pileus which is attenuated outwards. On the ground. S.A.—Back Valley, off Inman Valley. May, 1929.

Characterised by the rich salmony-buff pileus becoming pinkish-buff, contrasting with the close white gills and short pallid stem slightly tinted like the pileus.

519. *Collybia abutyracea*, n. sp.—Pileus up to 4¾ ins. (11·8 cm.) in diameter, at first convex with the edge turned in, then expanding, irregular and repand and more or less subumbonate, at first slightly velutinate, finely somewhat shining and subfibrillose, when young pallid or Cream Buff (xxx.) with a smoky brown tinge, then pallid biscuit-coloured, sometimes with a smoky or scorched tinge, sometimes with the umbo approaching Saccardo's Umber (xxxix.). Gills slightly sinuate to adnate, close, rather dingy creamy white, becoming more biscuit-coloured. Stem up to 1½ in. (3·7 cm.) high, rather slender to moderately stout, ⅜ to ½ in. (10 to 12·5 mm.) thick, coarsely fibrillose, equal, not rooting, tough and cartilaginous but with the flesh not very clearly distinct from that of the pileus, solid, not stuffed, breaking up into tough fibrils, dark smoky brown to pallid brownish, base whitish when young. Spores elliptical, 7·5 to 9 × 5 to 5·5 μ. No special smell. Amongst grass. S.A.—Beaumont Common, Pinnaroo, Belair. June, July, August.

520. *Collybia eucalyptorum*, n. sp.—Pileus ⅝ to 1½ in. (1·6 to 3·7 cm.) in diameter, broadly conico-campanulate to nearly plane, then slightly upturned, smooth, with the surface dull from innate fibrils, edge slightly striate, Pale Pinkish Buff becoming Cinnamon Buff (xxix), or Ochraceous Buff (xv.) and darker in the centre, becoming pallid towards the periphery. Gills adnexed, close, narrow, with short ones at the periphery, creamy-white or approaching Warm Buff (xv.). Stem 1 to 2½ ins. (2·5 to 6·2 cm.) high, relatively slender (⅛ in., 3·5 mm., or more thick), flexuous, smooth or subfibrillose, barely striate, hollow, cartilaginous, differing from the flesh of the pileus, reddish-brown (between Tawny, xv., and Russet, xv.; Mikado Brown, xxix.). Flesh thin, slightly brownish. Smell moderately strong. Spores pear-shaped, hyaline, 5 to 5·5 × 3·5 μ. Caespitose at the bases of old trunks of *Eucalyptus* or stumps. S.A.—Mount Lofty Summit, June.

521. *Mycena subgalericulata*, n. sp.—Pileus ½ to 1 in. (1·2 to 2·5 cm.) in diameter, ⅓ to ¾ in. (0·8 to 1·8 cm.) high, conico-campanulate, somewhat expanding, umbonate, dry, smooth, submembranaceous, somewhat striate to the umbo, near Olive Brown (xl.), occasionally paler (Buffy Brown, xl.), sometimes Mummy Brown (xv.), during drying becoming paler from above from Olive Brown to Buffy Brown, when young with a pallid peripheral ring. Gills adnate, sometimes

with a slight decurrent tooth, sometimes connected by veins, whitish, sometimes flesh-tinted or greyish when old. Stem $\frac{3}{4}$ to 2 ins. (1·8 to 5 cm.) high, often curved, smooth, polished, somewhat fragile to rather tough, base somewhat strigose, whitish to pallid, sometimes brownish especially below. Shed spores elliptical, oblique, 9 to 13 × 5·5 to 8·5 μ. No cystidia seen. No smell. Caespitose on trunks. S.A.—Mount Lofty (on trunks of *Eucalyptus obliqua* L'Hérit.), National Park. April, June, July, August.

This is evidently a variable species. It differs from Rea's description of *Mycena galericulata* (Scop.) Fr. in being of smaller size, with the cap apparently darker, the gills sometimes becoming greyish when old, and in the stem often being nearly pure white.

The characteristics of the species are the caespitose habit on trunks or stumps, the dark fuscous brown to pale smoky brown umbonate pileus, the gills adnate sometimes with a decurrent tooth and whitish becoming flesh-coloured or greyish, and in the whitish or pallid stem sometimes brownish below.

522. *Mycena australiana*, n. sp.—Pileus $\frac{1}{2}$ in. (1·2 cm.) high, $\frac{3}{4}$ in. (1·8 cm.) broad, broadly conico-campanulate, slightly striate, Buffy Brown to Clove Brown (xl.) or Wood Brown (xl.), apex darker. Gills adnate, with no decurrent tooth, moderately close, pure white becoming creamy. Stem about 3·7 cm. high, slender, polished, a little mealy at the base but without strigose hairs, apex whitish, Buffy Brown towards the base. Spores 8·5 to 11 × 6 to 7·5 μ. Gregarious or caespitose on fallen log. S.A.—National Park, Mount Lofty. May, June, July.

523. *Mycena vinacea*, n. sp.—Pileus $\frac{3}{4}$ to $1\frac{1}{2}$ in. (1·8 to 3·7 cm.) in diameter, conico-hemispherical or broadly conical to convex, then expanded, sometimes with an acute or obtuse umbo, matt or smooth, slightly shining, striate at the periphery when moist, edge slightly incurved when young, Pale Vinaceous Drab to Vinaceous Drab (xlv.), Light Cinnamon Drab (xlvi.), near Sorghum Brown (xxxix.) or yellower than Vinaceous Brown (xl.), sometimes Fuscous (xlvi.) when old, drying to near Pinkish Buff (xxix.), paler than Avellaneous (xl.) or between Avellaneous and Olive Buff (xl.). Gills adnate or slightly sinuate with a decurrent tooth, moderately close, ventricose, many short, edges tending to be frayed, Pale Vinaceous Drab, Pale Brownish Drab (xlv.), Pale Greyish Vinaceous, or Vinaceous Fawn to Fawn Colour (xl.). Stem 1 to $2\frac{3}{4}$ ins. (2·5 to 6·8 cm.) high, slender to a little stout, equal or slightly attenuated upwards or downwards, smooth, hollow, base pallid and tending to be villose, Dark Vinaceous Drab (xlv.) when young, Light Greyish Vinaceous (xxxix.), near pale Brownish Drab or Wood Brown (xl.). The pallid brownish flesh of the cartilaginous stem heterogeneous from the white flesh of the pileus. Spores obliquely elliptical, 7·5 to 13 × 4 to 8·5 μ. Caespitose or subcaespitose on fallen wood on the ground, at the base of stumps, or amongst fallen leaves and grass or pine needles. S.A.—Mount Lofty, National Park, Baker's Gully near Clarendon, Kuitpo, Kinchina, Kalangadoo (under *Pinus)*, Caroline State Forest (near Mount Gambier—under *Pinus)*. N.S.W.—Cambewarra Mount. May, June, July, August.

Readily recognised by the lilacy or vinaceous tint of the whole plant and the caespitose habit.

524. *Mycena subalbida*, n. sp.—Pileus up to $\frac{1}{4}$ in. (6·2 mm.) in diameter, usually less, conico-campanulate to convex, sometimes dimpled, sometimes gibbous or umbonate, ribbed, mealy or scurfy to glabrous, white with a greyish-brown or creamy tint. Gills adnate, attached to a collar, ascending, slightly ventricose, rather narrow, about 12 to 14 in number with shorter ones interposed, pallid greyish white. Stem $^3/_{16}$ to $\frac{3}{8}$ in. (4·5 to 10 mm.) high, curved, very slender, mealy to smooth, white to pallid, sometimes slightly brownish below, attached by a minute slightly strigose disc. Spores subspherical, 9 to 11 μ, 10 × 8·4 μ; the

cells on the edges of the gills bristling with minute processes; cystidia, 25 μ long, with tapering apices and ventricose bases seen in one batch of specimens. S.A.—On mossy bark of elms (*Ulmus campestris* L.), North Terrace, Adelaide, June, July; on bark of *Schinas Molle* L., Fullarton, July; on trunk, National Park (spores 9·5 × 6·5 μ).

The species seems to be related to *M. corticola* Fr. and *M. hiemalis* (Osb.) Fr., but differs and belongs to the section Basipedes by having a definite though small disc. We cannot find a description to fit it.

525. *Leptonia fusca*, n. sp.—Pileus ¾ to 1⅛ in. (1·8 to 2·8 cm.) in diameter, slightly convex, umbilicate, radiately fibrillose, between Natal Brown and Bone Brown (xl.). Gills sinuately adnexed, moderately close, edges not dark, near Vinaceous Buff (xl.). Stem 1¼ in. (3·1 cm.) high, slender, sometimes flattened, polished, brittle, hollow, cartilaginous, near Dusky Drab (xlv.), base whitish. Flesh very thin. Spores angular, tinted, 11 to 13 × 7·5 μ. On the ground. S.A.—Encounter Bay. May 24, 1931.

Characterised by the dark dusky brown pileus and stem, whitish base to the stem, vinaceous buff gills and rather large angular spores.

526. *Clitopilus prostratus*, n. sp.—Pileus ¾ to 1 in. (1·8 to 2·5 cm.) in diameter, very irregular, more or less convex with the centre depressed, somewhat rugose, somewhat fibrillose, edge sometimes crinkled, colour of dead grass. Gills decurrent, moderately close, relatively deep, pallid salmon-colourd. Stem short (1 cm.), central to excentric, slender, surface matt, whitish. Spores angular with a central yellowish gutta, tinted, 9·5 to 10·5 × 7·5 μ. Nearly prostrate on bare sandy soil in heathy scrub. S.A.—Near Mount Burr (S.E.). May, 1931.

527. *Clitopilus subfrumentaceus*, n. sp.—Pileus 1¼ to 4 ins. (3 to 10 cm.) in diameter, irregularly convex, then more expanded or with the centre depressed, often distorted, sometimes with a small umbo, subfibrillose, edge turned in when young, not shining, somewhat hygrophanous, Pinkish Cinnamon, Cinnamon, Sayal Brown, or Mikado Brown (xxix.) becoming paler. Gills adnate to adnate-decurrent, narrow, moderately close, edges sometimes irregularly serrate, rarely forking or anastomosing near the stem to form long narrow cells, Light Pinkish Cinnamon (xxix.). Stem 1½ to 2½ ins. (3·7 to 6·2 cm.) high, stout (up to ⅞ in., 2·2 cm. thick), base swollen (1 in., 2·5 cm. thick), sometimes a little excentric, somewhat mealy or fibrillose, solid, pale fawny or biscuity whitish or white. Flesh watery semi-translucent becoming whitish. Slight smell of radishes. Spores obliquely pear-shaped, rather irregular, definitely tinted, 6·5 to 8·5 × 4·2 to 6 μ. Densely caespitose under trees or amongst grass. S.A.—Mount Lofty Range, National Park. Vict.—Ararat. April to August.

The specific name has reference to its resemblance to *Entoloma frumentaceum* (Bull.) Berk.

528. *Clavaria vinaceo-cervina*, n. sp.—Plants ½ to 2 ins. (1·2 to 5 cm.) high, nearly vertical or slightly spreading, from a short stem-like base very irregularly branching, sometimes with only a few branches or prong-like divisions, sometimes with a number of small branches, ultimate divisions short, prong-like, mostly blunt, sometimes acute and thorn-like, sometimes awl-like or finger-like, often fastigiate, the branches often irregularly flattened and the whole plant rugose, usually relatively slender but in some collections stouter and more knobby, Vinaceous Fawn (xl.) to Fawn Color (xl.), near a pale Vinaceous Russet (xxviii.), deeper than Vinaceous Buff (xl.), between Vinaceous Buff and Avellaneous (xl.), Vinaceous Pink (xxviii.) at the tips with the stem Vinaceous Fawn (xl.), greyer than Buff Pink (xxviii.), or Pinkish Cinnamon (xxix.) with a fine bloom giving a vinaceous pink colour tinge on the pinkish cinnamon, base of stem pallid. Spores subspherical 7·5 to 9 μ, 8 × 6·5 μ, 9 to 10 × 8 to 8·8 μ. On the ground under

trees amongst shrubs. S.A.—Stirling West, July 23, 1927; Mount Lofty, April, June (Kew No. 86), July; Belair, July; Clare, August.

Specimens of this species (Kew, No. 86) were sent to Miss E. M. Wakefield, who reported: "Probably new. Not European or American."

529. *Clavaria australiana*, n. sp.—Densely branched, up to 4 ins. (10 cm.) high and 5 ins. (12·5 cm.) broad, the branches between Vinaceous Buff (xl.) and Avellaneous (xl.), their tips near Vinaceous Fawn and Fawn (xl.). Contracting uniformly from above to a broad conical base of several stout compacted stems. The thick main branches spread somewhat and divide rather sparingly and very irregularly till the last ¾ in. is reached. Here they divide frequently into numerous blunt irregular prongs, often at wide angles, the prongs often divided again and flattened. The stout main branches and the branchlets are definitely rugose. Spore mass slightly but definitely coloured. Spores microscopically slightly coloured, elongated, oblique, mummy-shaped, not striate, 13 to 16 × 4·5 to 5·5 μ. S.A.—On the ground, Mount Lofty, July, 1927.

530. *Clavaria corallino-rosacea*, n. sp.—Clubs simple, occasionally forked several times, up to 1½ to 2¼ ins. (4 to 5·6 cm.) high, prongs when present up to 1 cm. long, slender, attenuated downwards and also sometimes upwards, sometimes rather flattened and grooved, solid, coral red or rosy pink (when moist a little pinker than Morocco Red, Dauthenay, Pl. 95, Ton. 1; when drying shades of Coral Red, Pale Scarlet, Salmon Pink, Pl. 76), often pruinose above, when buried under leaves base whitish. Flesh light coral red. Spores somewhat pear-shaped, 6 × 3·4 to 4 μ. On the ground, sometimes under *Lantana*. N.S.W.—Mosman (Kew, No. 81; D.I.C., Water-colour No. 54) and Neutral Bay, Sydney, April and June.

Miss E. M. Wakefield, in reporting on No. 81, says:—"Probably the same as the Brisbane specimen (Bailey 241) on which the Australian record of *C. miltina* was founded. The true *miltina* from South America is stouter and has no distinct stem. Unfortunately, the type shows no spores, but it seems unlikely that the Australian species would be the same."

531. *Clavaria complana*, n. sp.—Forming a mass 3 ins. (7·5 cm.) high and 5 ins. (12·5 cm.) broad. From the solid base dividing repeatedly into slender branches which then become flattened and expanded, and then again divide into slender digitate processes ¼ in. (6 mm.) long, pale pinkish tussore, becoming brownish salmon, when damp staining paper pinkish salmon. Spores hyaline, subspherical, 5·2 to occasionally 7 μ. N.S.W.—Sydney suburb, probably Hornsby, June 13, 1916 (Kew, No. 68).

Miss Wakefield reported as follows:—"The habit is like that of *C. flabellata* Wakef. from New Caledonia, but the colour is different and the spores larger. It differs from most of the other large branched forms in its hyaline spores."

532. *Clavaria sinapicolor*, n. sp.—Densely branched forming masses up to 2¼ × 2¼ ins. and 3 × 3 ins. (5·6 × 5·6 cm. and 7·5 × 7·5 cm.), near Mustard Yellow (xvi.) or yellower, Straw Yellow (xvi.) and Colonial Buff (xxx.), Naples Yellow (xvi.) or dingier, or Light Orange Yellow (iii.), when old near Chamois (xxx.) but yellower towards the tips or near Cinnamon Buff (xxix.), the bases of the branches paler, the stem whitish. The main branches are compacted into a broad mass at the base up to 1¼ in. (3·1 cm.) thick. Dividing upwards repeatedly by very narrow angles into closely pressed nearly vertical more or less rounded rather slender slightly rugose branches, at first ¼ in. (6·5 mm.), then ⅛ in. (3·2 mm.) and then less in diameter, the last ¼ to ½ in. ending usually in numerous rather blunt prongs, some very short, often with wider angles between them than in the branches. Spore mass slightly but distinctly buff-tinted or old gold. Spores obliquely pear-shaped to elliptical, slightly tinted microscopically, 5·5 to 8 occasionally 10·4 × 3·8 to 4·5, occasionally 5 μ. On the ground, usually

in Eucalyptus *(e.g., E. obliqua)* forests. S.A.—Mount Lofty (Kew, Nos. 65, 75, 76), Kuitpo, National Park. N.S.W.—National Park (Kew, No. 66, Miss Clarke, Water-colour No. 126), Kendall, Milson Island in Hawkesbury River (smaller, Kew, No. 67). May to August.

Five collections, as above, were submitted to Miss E. M. Wakefield at Kew, who reported as follows:—"Nos. 65 and 66 are apparently the same as No. 75 and 76. The species is not British or North American. There is no specimen of *C. Kalchbrenneri* Müller at Kew, and the meagre description does not fit it very well. It would probably be better described as new. One of Cooke's determinations of *'C. coralloides,'* from Ovens River, seems to be the same species. No. 67 has spores similar to the last, but appears to have been a smaller and less branched plant. The material is insufficient to enable me to judge as to habit."

533. *Clavaria ochraceo-salmonicolor*, n. sp.—Compact, cauliflower-like $1\frac{3}{4}$ to $3\frac{1}{2}$ ins. (4·4 to 8·7 cm.), usually about $2\frac{1}{2}$ ins. (6·2 cm.) high, 2 to 3 ins. (5 to 7·5 cm.) broad in larger specimens. From a thick pallid base up to 1 in. (2·5 cm.) wide, dividing into stout branches (up to $\frac{3}{8}$ in., 10 mm. thick) and these again dividing three or four times to end in blunt prong-like processes capped by several blunt teeth a few mm. long, angles rather rounded, branches with longitudinal rugae. Colour Light Ochraceous Salmon (xv.), Ochraceous Salmon (xv.), Light Ochraceous Buff (xv.), or Apricot Buff (xv.) when drying; when young Capuchin Orange (iii.), the tips yellower, which yellow may be lost when older; tips sometimes Warm Buff (xv.) or Ochraceous Buff (xv.). Spores elongated pear-shaped with an oblique apiculus, in the mass yellowish-brown, microscopically slightly tinted, 8·5 to 13 $\times$ 3·7 to 5 μ, usually about 9 to 10 $\times$ 4 μ. S.A.—Mount Lofty (Kew, No. 71), Willunga Hill, Second Valley Forest Reserve, MacDonnell B. (in S.E.), April, May, June, July.

Specimens from Mount Lofty, June 16, 1917, forwarded to Kew, were returned by Miss Wakefield as "not matched at Kew."

NOTES ON SOME SOUTH AND CENTRAL AUSTRALIAN MAMMALS.

PART 2.

By H. H. FINLAYSON.

[Read October 8, 1931.]

1. Since recording the presence of *Thalacomys lagotis* in the Musgrave Ranges (Trans. Royal Soc. S. Aust., 1930, p. 178), further specimens have been obtained from localities in the centre, considerably further north.

In August, 1930, Messrs. Hale and Tindale, during the stay of the Adelaide University Anthropological Expedition in the Centre, obtained a male and female from the blacks at Macdonald Downs, about 120 miles north-east of Alice Springs. And again in August of this year, when attached to a similar party, Mr. A. Rau, of the Museum staff, obtained a male at Cockatoo Creek, on the Tanami track, about 150 miles north-west of Alice Springs, in latitude 22° S., approximately.

All three specimens present the characters of *lagotis*, previously noted in the Opparinna example. The largest male, got at Macdonald Downs (S.A. Museum, M 2930), had the following flesh dimensions:—Head and body, 415; tail, 270; pes, 100; and its skull, which is massive and strongly ridged, has a basal length of 98 and zygomatic breadth of 54. The female, taken at the same place, has:—Head and body, 320; tail, 235; pes, 88; and the skull is smooth and devoid of crests, and has basal length 78 and zygomatic breadth 39. Both specimens are aged and show about the same degree of tooth wear; the sexual differences in size and contours are, therefore, extraordinarily marked. The male skull weighs 34 grammes, and the female 15 grammes.

Mr. L. Glauert, Director of the Western Australian Museum, has recently examined a splendid series of 40 *lagotis*, culled from Western Australian localities and, pending completion of his work, has been good enough to inform me in advance of some of his findings. It would appear that even in comparatively restricted areas the adult size is far from constant and varies sufficiently to embrace all four of the Central specimens I have noted.

Under these circumstances, I withdraw the remark that the Central *lagotis* is a dwarfed form, as being at present insufficiently founded.

2. The disappearance of the short-nosed bandicoot, *Isoodon obesulus*, from the greater part of South Australia is a typical example of a number of similar faunal declines occurring, sometimes over areas almost continental in extent; sometimes, as in this case, in restricted localities, but always without adequate cause being apparent.

Originally widely distributed in this State, and in some parts in great numbers, *Isoodon* remained a common and familiar animal long after the beginnings of settlement, and indeed seems to have received its first serious check not more than 30 years ago. Since then it has dwindled to such an extent that the present generation of settlers has largely forgotten even its name, and when, rarely, one is taken, extraordinary speculations as to its identity are heard. In the last 10 years nearly all specimens obtained at the Museum have come from localities in the South-Eastern district, adjoining Victorian territory, where it is much more common, and Wood Jones' record of one from Blackwood (Mammals of S.A., vol. ii., p. 138) has remained unique for the Adelaide district till quite recently.

The causes usually quoted in explanation of these disappearances are the prevalence of foxes and of feral cats, the occurrence of epidemic diseases, the laying of poison baits, competition with the rapidly breeding rabbit, and the burning off of large areas at frequent intervals, and no doubt all these have played a part. But that these in themselves are inadequate to account for all the observed facts, and that other and more fundamental factors are involved, is shown by the still more mysterious recurrence of "extinct" species from time to time, with no apparent change in ecological conditions.

There are now unmistakable signs that the recovery of *I. obesulus* in the Mount Lofty Range is proceeding apace. During the opossum season of 1930 it was constantly reported as being taken by trappers, and some dozens of pelts were sent into the sale rooms, and during the last few months four specimens have come to hand from localities within 20 miles of Adelaide.

The characters of the local race have been fully stated by Wood Jones *(loc. cit.)*

3. From time to time reports have been received by the writer of a small wallaby or "kangaroo rat," occuring sparsely in spinifex country in several localities in the far northern areas of the State. Descriptions of its appearance and habits were sufficiently precise and consistent to rule out both *Bettongia lesueuri* and *B. penicillata* from its possible identity, and it appeared certain that it was one of the hare wallabies, probably *Lagorchestes hirsutus,* which was obtained by the Elder Expedition towards the north-west boundary of the State.

About a year ago an opportunity occurred of questioning a practised observer who had seen the living animal at close quarters and had handled specimens of it, dead. When confronted with a series of filled skins of *L. conspicillatus leichardti, L. c. typicus, L. hirsutus, Bettongia lesueuri, B. penicillata,* and *Aepyprymnus rufescens,* he was quite emphatic that the spinifex wallaby was not represented.

Finality has now been reached (September 10), on receipt of a skin and skull of the animal, which proves to be *Caloprymnus campestris,* described by Gould in 1843, recorded again by Tate in 1878, and since then a "lost" species.

Externally it is very distinct both from the other Potoroinae and from the Lagorchestines, and its skull characters are, fortunately, so peculiar and pronounced as to remove any element of doubt from the identification.

Field work in the locality of the occurrence will at once be undertaken and, pending its completion, a revision of the characters of the animal is deferred.

PETROGRAPHIC NOTES ON SOME BASIC ROCKS FROM THE MOUNT BARKER AND WOODSIDE DISTRICTS.

By A. R. Alderman, M.Sc., F.G.S.

[Read October 8, 1931.]

Basic rocks have been recorded from various localities in the Mount Lofty Ranges in South Australia.[1] The rocks described in this paper occur as follow:—

I. Basic dyke, sections 5267 and 5269, Hundred of Onkaparinga; about two miles east of Woodside.

II. Basic dyke, sections 3828 and 3829, Hundred of Macclesfield; one to two miles north-west of Mount Barker (the hill), and not far from Mount Barker Springs.

III. Basic dyke, sections 4213, 4214, and 4216, Hundred of Onkaparinga; near Mount Barker Junction railway station.

For brevity these occurrences will be referred to as: I., Woodside; II., Mount Barker Springs; and III., Mount Barker Junction. References to these rocks have been made by Howchin,[2] Benson,[3] and others.

The age of the intruded sediments is somewhat doubtful, owing to their metamorphosed condition, but recent work by Prof. W. Howchin[4] seems to indicate that at Mount Barker Springs and Mount Barker Junction they are Upper Pre-Cambrian (Adelaide Series). The intruded rocks at Woodside may be of the same age or Lower Pre-Cambrian (Barossian).

I. The Woodside rock occurs as a broad basic dyke striking in roughly a north-west direction. When examined in the hand specimen the rock appears dark and holocrystalline. It is of porphyritic habit, felspar crystals, up to 5 mm. in length, being embedded in a dark fine-grained groundmass. Some specimens contain far more felspar phenocrysts than others. The rock analysed, and described first, is of the more felspathic type.

Microscopic Features.—The structure is essentially porphyritic, in which large felspar phenocrysts are embedded in a groundmass consisting mostly of felspar and hornblende.

The *felspar* is a basic labradorite, mostly in oblong forms but occasionally showing square cross-sections. Both albite and pericline twinning is common, Carlsbad twins also being occasionally seen. The felspar crystals contain innumerable inclusions of all sizes, the larger of these generally being amphibole although sphene sometimes occurs in this way, and, of course, the felspar alteration products.

Minute inclusions are extremely numerous and are very often arranged in rows parallel to the sides of the felspar crystals. These inclusions consist of both amphibole and chlorite, the latter evidently being an alteration from the former. The arrangement of these parallel to the crystal faces suggests inclusion of the mother liquors during rapid crystallisation of the felspar. Many of these small

(1) Mawson, D., Rept. A.A.A.S., vol. xviii., 1926, pp. 251-252.

(2) Howchin, W., "Geology of South Australia" (sec. ed.), 1929, pp. 61-62.

(3) Benson, W. N., Trans. Roy. Soc., S. Aust., vol. xxxi., 1909, p. 240.

(4) Howchin, W., Trans. Roy. Soc., S. Aust., vol. liii., 1929, pp. 27-32.

inclusions are arranged with a similar optic orientation. Some of the felspar is somewhat obscured by dusty kaolinitic material.

After the felspar, green *hornblende* is the most important mineral. It does not appear to be primary, but to have recrystallized in fine-grained aggregates. No indication of a uralitic nature is shown. It is pleochroic from light to darker green. The smaller individuals, and a few of the larger, show an alteration to chlorite.

Scapolite is a notable constituent and in ordinary light it resembles the felspar, but is easily distinguished by its higher colours between crossed nicols. Grains of this mineral occur adjacent to the felspars, from which they are apparently derived by alteration.

Grains of *zoisite* are common, and although they are sometimes found in separate individuals they generally occur with an aggregate of kaolinitic matter and felspar showing a distinct poikiloblastic structure. Some small colourless grains in this aggregate are probably albite, suggesting that the felspar has been saussuritized.

The opaque iron ore is *ilmenite,* which shows an alteration to leucoxene.

Sphene is present in dusty grey-brown grains which are occasionally wedge-shaped.

A narrow vein of *secondary quartz* is to be seen in one portion of the section examined.

Chemical Analysis.

	Percentage.		Percentage.
Silica (SiO_2)	47·63	Carbon dioxide (CO_2)	Nil
Alumina (Al_2O_3)	21·94	Titanium dioxide (TiO_2)	0·77
Ferric oxide (Fe_2O_3)	1·81	Phosphorus pentoxide (P_2O_5)	0·15
Ferrous oxide (FeO)	4·59	Sulphur (S)	0·15
Magnesia (MgO)	5·81	Chromic oxide (Cr_2O_3)	Trace
Lime (CaO)	14·08	Manganous oxide (MnO)	0·08
Soda (Na_2O)	1·79	Barium oxide (BaO)	Nil
Potash (K_2O)	0·28		
Water (combined) (H_2O+)	0·68	Total	99·79
Water (hygroscopic) (H_2O-)	0·03		

The specific gravity is 2·95.

The Norm.

	Percentage.		
Orthoclase	1·67	F = 67·74	Salic Group = 67·74%
Albite	15·20		
Anorthite	50·87		
Diopside	14·52	P = 24·16	
Hypersthene	9·64		
Olivine	2·42	O = 2·42	
Ilmenite	1·52	M = 4·07	Femic Group = 31·26%
Magnetite	2·55		
Apatite	0·34	A = 0·61	
Pyrite	0·27		
Water	0·71		

In the C.I.P.W. classification the position of the rock is, therefore:—

II., 5, 4, 4-5.

The magmatic name is *Hessose.*

The high felspar content is indicated by the high percentages of lime and alumina giving over 50% of anorthite in the norm. Actually a good deal of this lime and alumina must enter into the modal hornblende. Apart from these points the analysis seems quite normal for a rock of this type, and supports the idea gained from the mineral content that it must be classified in the basic division of the calc-alkali series.

Another specimen from the same locality differs from the rock analysed mainly in containing a smaller amount of felspar. This mineral, which has the composition of a medium labradorite, again shows twinning on the albite, pericline and Carlsbad laws, and contains the numerous inclusions mentioned in the description of the former rock. These phenocrysts, in some cases, consist of a number of individual crystals which have grown together. The felspars again have suffered an alteration round the edges to scapolite and epidote, but not to the extent noted in the rock analysed. The amphibole, also, is somewhat paler.

II. The occurrence of the Mount Barker Springs rock is described by Howchin. He writes that: "A basic dyke, 28 yards wide, occurs about two miles to the north-west of Mount Barker Hill, with a strike directed towards the mount, and can be traced for nearly a mile; its age is undetermined."[5] In a more recent paper[6] the same writer indicates that the intruded rocks are most probably Adelaide Series sediments.

In the hand specimen colourless porphyritic felspars, many measuring up to 5 mm. in length, are embedded in a dark, somewhat greenish groundmass.

Microscopic Features.—The porphyritic texture is again well displayed by the presence of large plagioclase crystals in a groundmass consisting mainly of hornblende and plagioclase.

The felspar is a medium *labradorite* in which albite, pericline and Carlsbad twinning is well developed. Inclusions in the felspar phenocrysts are less numerous, but of the same nature as those in the Woodside rocks.

The *hornblende* also is similar to that in the more felspathic rock at Woodside.

Granules of *scapolite* are associated with some of the felspar phenocrysts.

Both *zoisite* and green *epidote* are frequently surrounded by fine sericitic material, these aggregates constituting alteration products of the felspar.

Small granules of *ilmenite*, changing to leucoxene are plentiful. A small quantity of *sphene* is also present.

Chemical Analysis.

	Percentage.		Percentage.
Silica (SiO_2)	49·29	Carbon dioxide (CO_2) ..	Nil
Alumina (Al_2O_3)	18·41	Titanium dioxide (TiO_2) ..	1·01
Ferric oxide (Fe_2O_3)	1·00	Phosphorus pentoxide (P_2O_5)	0·21
Ferrous oxide (FeO)	5·87	Sulphur (S)	0·05
Magnesia (MgO)	8·68	Chromic oxide (Cr_2O_3) ..	Nil
Lime (CaO)	13·03	Manganous oxide (MnO) ..	0·15
Soda (Na_2O)	1·18	Barium oxide (BaO)	Nil
Potash (K_2O)	0·28		
Water (combined) (H_2O+)	0·67	Total	99·87
Water (hygroscopic) (H_2O-)	0·04		

The specific gravity is 3·00.

(5) "Geology of South Australia" (sec. ed.), 1929, p. 62.

(6) Trans. Roy. Soc. S. Aust., vol. liii., 1929, pp. 27-32.

The Norm.

	Percentage.			
Quartz	1·20		Q = 1·20	
Orthoclase	1·67	}	F = 55·55	Salic Group = 56·75%
Albite	9·96			
Anorthite	43·92			
Diopside	16·09	}	P = 38·63	
Hypersthene	22·54			
Ilmenite	1·98	}	M = 3·37	Femic Group = 42·34%
Magnetite	1·39			
Apatite	0·34		A = 0·34	
Water	0·71			

In the C.I.P.W. classification the position of the rock is, therefore:—

III., 5, 5, 4-5.

approaching: III., 5, 4, 4-5.

The magmatic name is *Auvergnose-Kedabekase.*

The analysis shows lower alumina, lime and soda than the Woodside rock. This is reflected in the smaller amount of normative felspar. The ferromagnesian content is correspondingly higher. In these points the norms indicate the actual mineralogical differences between the two rocks. It is probable that the less felspathic type from Woodside would be extremely similar, chemically, to that occurring at Mount Barker Springs.

III. As mentioned by Howchin,[7] the basic dyke at Mount Barker Junction is not seen in outcrop, its presence being indicated by loose stones on the surface of cultivated land. In the hand specimen this rock bears an extremely close resemblance to that from Mount Barker Springs.

Microscopic Features.—Porphyritic felspars occur in a groundmass of hornblende and felspar, this structure being similar to that of the rocks described above. The *plagioclase* phenocrysts again contain numerous inclusions which are mostly chlorite. Extinction angles indicate that the felspar is a medium labradorite. This felspar, although it is corroded, differs from that of the other rocks in that no scapolite has been formed, although both *zoisite* and green *epidote* are present in small amount. The twinning of the plagioclase is confined to the albite and Carlsbad types, no pericline twins being seen.

The *hornblende* is similar to that of the other rocks and is somewhat chloritized.

Sphene is a notable constituent, but iron ores are practically negligible.

Chemical Analysis.

	Percentage.		Percentage.
Silica (SiO_2)	49·09	Water (combined) (H_2O+)	0·89
Alumina (Al_2O_3)	18·03	Water (hygroscopic) (H_2O-)	0·05
Ferric oxide (Fe_2O_3)	3·35	Carbon dioxide (CO_2)	Nil
Ferrous oxide (FeO)	4·56	Titanium dioxide (TiO_2)	1·38
Magnesia (MgO)	7·48	Phosphorus pentoxide (P_2O_5)	0·21
Lime (CaO)	12·97	Manganous oxide (MnO)	0·18
Soda (Na_2O)	1·71		
Potash (K_2O)	0·42	Total	100·32

The specific gravity is 3·01.

(7) *Loc. cit.*, p. 31.

The Norm.

	Percentage.			
Quartz	2·58		Q = 2·58	
Orthoclase	2·22	}		Salic Group
Albite	14·15	}	F = 56·68	= 59·26%
Anorthite	40·31	}		
Diopside	18·71	}	P = 32·12	
Hypersthene	13·41	}		
Magnetite	4·87	}	M = 7·61	Femic Group
Ilmenite	2·74	}		= 40·07%
Apatite	0·34		A = 0·34	
Water	0·94			

In the C.I.P.W. classification the position of the rock is, therefore:—

III., 5, 4, 4-5.

The magmatic name is *Auvergnose*.

The analysis shows the extreme chemical similarity between this and the Mount Barker Springs rock. There are, however, minor variations in the alkalies and the relative amounts of iron and magnesia.

Conclusion.

The mode of occurrence, mineralogical nature, and chemical composition of these three rock types suggest that they are closely related, and that they should be included in that class of rock to which the misleading name *epidiorite* has been given.

The writer would suggest, however, that the compound name *dolerite-amphibolite* could be applied advantageously to types such as have been described in this paper.

ABSTRACT OF THE PROCEEDINGS

OF THE

ROYAL SOCIETY OF SOUTH AUSTRALIA (Incorporated).

FOR THE YEAR NOVEMBER 1, 1930, TO OCTOBER 31, 1931.

ORDINARY MEETING, NOVEMBER 13, 1930.

THE PRESIDENT (Dr. Chas. Fenner) in the chair and 28 members were present.

Minutes of the Annual Meeting, held October 9, 1930, were read and confirmed.

ELECTION OF FELLOW.—John Irvine Miller, C.E., Crystal Brook. A ballot was taken and Mr. Miller was declared elected.

CORRESPONDENCE.—A letter received from Dr. A. B. Walkom, Secretary of the Linnean Society of New South Wales, was read, relating to the publication of reproductions on coloured plates of some of the Australian native flora.

A GENERAL DISCUSSION on "Laterite and Lateritic Soils" was introduced by Professor J. A. PRESCOTT, who said that "laterite was originally defined in 1807 from certain soil formations and geological structures in Southern India by Buchanan. Laterites occur throughout a considerable area of Australia, and were first recognised as such in Western Australia by Simpson and by W. G. Woolnough. The essential feature of the laterite consists of a capping or conglomerate of massive or pisolitic iron hydroxide with certain examples of aluminium hydroxide or bauxite. Soil workers have assumed that the process of laterization was a distinct weathering process confined to the tropics, but further investigation has revealed no evidence in support of this, such tropical weathering processes being entirely similar to those occurring in temperate zones. It is suggested, therefore, that laterite, as defined by geologists, is essentially a relic of former soil-forming processes." Professor Prescott then read a letter dealing with the subject by Dr. L. Keith Ward. Mr. R. J. BEST then dealt with the chemical aspect, and illustrated his remarks with diagrams. Mr. J. G. WOOD described the ecology of the vegetation on tropical and Australian laterite soils. In Burma *indaing* forest, *Diptirocarpus tuberculatus,* with associated stunted shrubs was confined to the laterite. The vegetation of the sand plains under about 20-in. rainfall was dealt with, and it was shown that it was not a variant of mallee, as Diels suggested. In South Australia there are three large laterite areas—at Mount Compass, southern Fleurieu Peninsula, and central Kangaroo Island. Stunted stringybark *Eucalyptus Baxteri* is the dominant shrub in soils containing laterite gravel, and the shrub-gum *Eucalyptus cosmophylla,* with *Casuarina striata* is dominant where the ironstone crusts are exposed. Mr. Wood discussed the relation of these shrubs to the climax stringybark community which represented the highest developmental phase of the vegetation in the climate under consideration. The scrub on laterite was an edaptic sub-climax of the stringy-bark

forest, prevented from normal development to high forests by soil conditions. He considered that the vegetation on laterite soils was not in equilibrium with its present environment. Mr. C. T. MADIGAN said that "laterite was a product of rock in arid regions, not, perhaps, necessarily tropical. Laterite was found overlying granites and gneisses and old igneous rocks generally, and is best known over this class of rock. It was a residual soil, and never transplanted. Consists of hydrated iron oxides, hydrated alumina (bauxite), clay, quartz grains, etc. Varies from pure limonite (hydrated iron oxide) to pure bauxite (hydrated alumina). The sand grains and clay are variable. There are large deposits in the Darling Range, near Perth (W.A.), which give about 35% soluble alumina, and 30% iron oxide. Some has as much as 50-60% of soluble alumina, which is a good aluminium ore." Mr. Madigan then discussed the conditions which determine whether rock silicates shall decay to clay (hydrated silicate of alumina) or to bauxite (hydrated alumina with free silica causing silicification, so common in Central Australia). Specimens were exhibited of Kangaroo Island laterite, identical in appearance to some from the Irwin River in Western Australia; amphibolite changing to laterite, from Magna, Western Australia; slate from Armadale undergoing a similar change, and typical laterites from Canegrass, Western Australia. Dr. R. LOCKHART JACK said that "the great development of laterite in Western Australia is undoubtedly a product of past activity, and similar old lateritic bodies occur in South Australia to the west and north-west of Tarcoola and south of the Musgrave Ranges, as well as in the south. Topography, the nature of the underlying rocks, climate, and the position of the ground-water table must have affected its formation. The comparison with the Desert Sandstone is difficult, as the laterite is characteristic of the older rock formations such as granite, gneisses, and schists, while the silicification which constitutes the Desert Sandstone is confined to the Jurassic and younger series. The silicification is most complete at the surface, and with increasing depth gradually merges into weathered material. It has affected the Eyrian beds, the Cretaceous and the Jurassic and the physical state of the bed that has been silicified is shown in the product, which ranges from fine-textured shale, completely silicified, to quartzitic conglomerate. Some of the original beds are ferruginous, and the Desert Sandstone over them may be limonite cemented. From topographic considerations there is no doubt but that this great silicification occurred over a widespread, ill-drained peneplain, and under somewhat wetter conditions than are known at present. Like travertine, it was formed by the capillary rise of mineralized water. With dissection and the development of drainage the process ceased save at favoured localities, such as in the vicinity of lakes where the water-table is within reach of the surface. At Lake Bring (gneiss-bottomed) and Lake Woorong (Jurassic sands and grits) there are obviously later crusts, probably Recent in age. At Lake Bring both iron and silica cement a fine sand-grain aggregate, while at Lake Woorong the cement is siliceous with a similar aggregate, which is dissimilar in grain to the subjacent Jurassic grits, but may have been derived from them by subsequent redistribution. The Woorong crust, exposed over many acres, is about two feet thick. Originally flat, it has been broken and tilted in all directions by the rise of gypseous solutions from the saline ground-water and the deposition of microcrystalline gypsum beneath the crust. The formation of this gypsum argues a change of conditions in the climate resulting in increased salinity. There seems to be no doubt but that silicification, though no longer taking place on a large scale, has persisted till very recently, and that with the most recent silicification there has occurred, where supplies of iron are available, recent limonitic cements."

The Chairman thanked the members who had dealt with the various aspects of the subject.

Ordinary Meeting, April 9, 1931.

The President (Dr. Charles Fenner) occupied the chair and 30 members were present.

Minutes of the Ordinary Meeting, held on November 13, 1930, were read and confirmed.

The President extended a welcome to Mr. J. M. Black on his return from abroad, and then formally handed to him the Sir Joseph Verco Medal, which had been awarded by the Society to Mr. Black during his absence.

Mr. Black "thanked the President and Fellows for the great honour which the Society had seen fit to confer on him. He also wished to express his gratitude to Dr. L. Keith Ward, Mr. J. F. Bailey, and Dr. R. S. Rogers for their kindly, and too flattering, references to his work at the meeting of July 10 last, when it was decided to confer the medal upon him. The name associated with the medal must always awake pleasant recollections in the minds of those Fellows who, in past years, sat under the genial presidency of Sir Joseph Verco. That presidency endured for no less than 18 consecutive years from 1903 to 1921—a record perhaps only exceeded by that of Sir Joseph Banks, who for 25 years occupied the position of President of the Royal Society of London." Mr. Black, who represented the Royal Society, as well as several other Australian institutions, at the International Botanical Congress held at Cambridge in August, 1930, said "he hoped it would not be out of place if he gave a short account of the work accomplished in the Section of Taxonomy and Nomenclature, to which he was attached. It was at first feared that an agreement might not be reached between a large section of the Botanists of the United States of America and the rest of the world on the vexed question of *nomina generica conservanda,* but such a spirit of friendliness and compromise was apparent from the very beginning of the proceedings that there is no doubt that uniformity of nomenclature will be attained in the future. Indeed, a considerable list of additional and well-known generic names was proposed for conservation, but as it was impossible for a large assembly in one week to deal with such a complicated subject, its consideration was relegated to a small committee comprising some of the ablest and most experienced authorities on nomenclature. It was remarkable that three of the four members of the committee which drew up the International rules of the Vienna Congress in 1905 (Dr. J. Briquet, of Geneva; Dr. H. Harms, of Berlin; and Dr. A. B. Rendle, of London) are taking an active part in the same work today as an aftermath of the Cambridge Congress. The Congress was composed of over 1,000 members and represented almost every nation, including Japanese, Chinese, and Indian botanists. The only notable absentees were the Russians. Several Professors from Moscow, Leningrad, and Kiev were inscribed on the official programme to read papers on various subjects, but as none of them appeared, and no explanation was received, the cause of their non-attendance could only be surmised. From the social and scientific points of view, the gathering was a great success. There was a reception by the British Government at the Imperial Institute in London, and at Cambridge there were hospitable receptions by the Masters of St. John's College and of Downing College. At the Royal Botanic Gardens of Kew, the cosmopolitan guests were entertained by the popular Curator, Dr. A. W. Hill."

Election of Fellow.—Charles Ernest Cameron Wilson, M.B., B.S. A ballot was taken and Dr. Wilson declared elected.

Nomination as Fellows.—Hugh McIntyre Birch, M.R.C.S., M.R.C.P., medical practitioner, Mental Hospital, Parkside; Joseph Ronald Andrew, minister of religion, Woodside; Eric Aroha Rudd, student, 10 Church Street, Highgate.

The President drew the attention of members to invitations received to appoint Delegates to attend the Faraday and the Clerk Maxwell Celebrations at

the University of Cambridge, the Centenary Meeting of the British Association for the Advancement of Science, and the Centenary of the College of France, which will take place during 1931.

The President then requested all members who were preparing papers for presentation during the year, to advise the Secretary, so that a probable cost of publication can be obtained for the guidance of the Council.

The President expressed the sincere regret of the Society in the loss sustained by the departure from this State of Dr. R. Lockhart Jack, and on behalf of the Council and members requested the Secretary to convey to Dr. Jack the very best wishes and success in his new field of labour.

Papers—

"A Delineation of the Pre-Cambrian Plateau in Central and North Australia, with Notes of the Impingent Sedimentary Formations," by Chas. Chewings, Ph.D., F.G.S., was formally communicated by Mr. W. W. Weidenbach, A.S.A.S.M. Dr. Chewings, who was present, was then invited by the President to give a resumé of the work covered by his paper.

Mr. Madigan, Prof. Howchin, and Dr. L. Keith Ward took part in the discussion which followed. Dr. Ward drew special attention to the age of the sediments forming Ayers' Rock, as suggested by Dr. Chewings, and said that he doubted, on lithological grounds, if they were younger than Cambrian age.

The President expressed the appreciation of the Fellows to Dr. Chewings for his valuable contribution to the Geology of Central Australia.

Exhibits.—Mr. N. B. Tindale exhibited some fossils from Mount Ultim, and from Undala, Central Australia; they were found in horizontally bedded littoral marine sandstones, and although not yet critically determined appear to have a facies characteristic of the Ordovician. Professor Howchin exhibited photographs of Cryptozoön from the type district at Saratoga Springs, New York State, taken by Mr. A. R. Riddle (formerly of Adelaide, now of New York.) The fossils are photographed *in situ*, exposed on a glaciated pavement. They also include a photograph of a metal tablet placed on the ground, containing the following inscription in relief:—"Cryptozoön Ledge. The fossils on the surface of the rock are remains of marine plants or algae which grew over the bottom of the ancient Cambrian sea. They are among the oldest plants of the earth. They grew in cabbage-shaped heads, and deposited lime in their tissues. The ledge has been planed down by the action of the great glacier which cut the plants across, showing their concentric interior structure. The scientific name of these plants is Cryptozoön proliferum Hall." Mr. A. M. Lea exhibited some stag-beetles *(Lucanidae)* from New Guinea, showing an extraordinary range of variation in the males, and for comparison the common stag-beetle of Europe *(Lucanus cervus)* and many Australian species. Also a Katipo, the dangerous red-backed spider *(Lactrodectus hasselltii)* and some new hatched ones. Another Katipo laid some eggs in captivity on January 14; still held captivity and without any possible connections with a male, a second lot of eggs was laid on February 18; these duly hatched. On March 26 a third lot was laid which were now coming out. Mr. Madigan exhibited a map he had compiled of the region in the vicinity of the MacDonnell Ranges from observations made during his recent aerial reconnaissance, and a subsequent visit to the locality; together with information obtained from other observers. The President (Dr. Chas. Fenner) exhibited specimens and casts of leaves of *Magnolia Browni*, from Baker's gully, near Clarendon. These are found in extensive deposits of ferruginous sands and grits, preserved in part on the old eastward tilted peneplain surface. This fossil was formerly regarded as Cretaceous, but is now known to be Miocene. The matter has a definite bearing on the physiographic history of the Mount Lofty Ranges, as well as on the interesting question of the origin of our lateritic soils. Mr. J. M.

Black showed dried specimens of *Alhagi camelorum* or "Camel Thorn," which has appeared in cultivated ground near Jamestown. It is a spiny shrub inhabiting desert country between Nubia and North-western India, and might become a pest here.

Ordinary Meeting, May 14, 1931.

The President (Dr. Charles Fenner) occupied the chair and 20 members were present.

Minutes of the Ordinary Meeting, held April 9, 1931, were read and confirmed.

Apologies were received from Dr. L. Keith Ward, Mr. B. S. Roach, and Mr. F. C. Martin.

The President referred to the publication of Part III., "The Building of Australia, and the Succession of Life," by Professor Walter Howchin. It was agreed that a letter expressing the congratulations of the Society be sent to Professor Howchin.

The President announced that an invitation had been received to send a Delegate to the Centenary Meeting of the Royal Society, Dublin, which will be celebrated in June of this year.

Election of Fellows.—Hugh McIntyre Birch, M.R.C.S., M.R.C.P., medical practitioner, Parkside; Joseph Ronald Andrew, Woodside; and Eric Aroha Rudd, Highgate, were balloted for and declared elected.

Nominations as Fellows.—Nelly Hooper Woods, M.A., school teacher, Mount Torrens; Charles Chewings, Ph. D., F.G.S., "Alverstoke," Glen Osmond, were read.

Papers—

"A Table Showing the Class Relations of the Aranda," by H. K. Fry, M.B., B.S., B.Sc., who exhibited diagrams showing the family relationships of these natives. Mr. N. B. Tindale exhibited a diagram mounted on a cylinder, to illustrate the four class-marriage classifications of the Iliaura tribe, MacDonnell Ranges, Central Australia. This diagram was based on the one devised for the Aranda tribe by Dr. H. K. Fry. The President, the Rev. J. C. Jennison, and Dr. T. D. Campbell took part in the discussion.

"The Anatomy of an Australian Leech, *Helobdella bancrofti*," by Mrs. Effie W. Best, M.Sc.

Exhibits.—Mr. A. M. Lea exhibited a drawer of Cuckoo-wasps. These remarkable insects are parasitic in the nests of mud-wasps, in which they live like cuckoos in the nests of other birds, and similarly destroy the young of the rightful inhabitants. Also a drawer of dung beetles, of which three species of *Pedaria* act as cuckoos, of the genus *Onthophagus*. Mr. H. H. Finlayson exhibited a photograph of the maxilla of *Neobalaena marginata*, with baleen *in situ*, and a baleen plate, collected by him on the West Sister Island, Bass Strait; which is now deposited in the South Australian Museum. He stated that although there were records of three strandings of this species in South Australian waters, which led to the acquiring of osteological material, the baleen of the adult was previously not represented in the Museum collections.

Ordinary Meeting, June 11, 1931.

The President (Dr. Chas. Fenner) occupied the chair and 44 members were present.

Minutes of the Ordinary Meeting, held May 14, 1931, were read and confirmed.

Election of Fellows.—Miss Nelly Hooper Woods, M.A., and Charles Chewings, Ph.D., F.G.S., were balloted for and declared elected.

NOMINATION AS FELLOW was received from Professor Sir Charles James Martin, Kt., C.M.G., D.Sc., University of Adelaide.

PAPERS—

"Geological Notes of the Iliaura Country, North-east of the MacDonnell Ranges, Central Australia," by N. B. TINDALE, was taken as read.

A number of popular lectures on "The Status of the Native Flora of South Australia," introduced by Mr. J. M. BLACK, were then delivered. Those contributing being Dr. R. S. Rogers, Mr. J. F. Bailey, Mr. J. G. Wood, Dr. R. Pulleine, and Professor J. B. Cleland.

Mr. J. M. BLACK introduced the subject and spoke on "The Great Changes taking place in our Native Flora by Introduced Plants."

Dr. R. S. ROGERS described "The Orchids of this State."

Mr. J. F. BAILEY, "Cultivated Plants."

Mr. J. G. WOOD outlined the work done at Coonamore.

Dr. R. PULLEINE, "Some Flora of the Gawler Ranges."

Professor J. B. CLELAND, "Notes on Collecting."

Mr. J. M. BLACK said "our Native Flora was being replaced to a very serious extent by alien introductions, of which many were weeds, although some, such as the clovers and some foreign grasses provided useful fodder. Near towns, and especially on the parklands of Adelaide, native plants had almost disappeared, and some of those which had taken their place, such as the Onion Grass *(Romulea rosea)*, the Nut Grass *(Cyperus rotundus)*, and the Two-leaved Cape Tulip *(Homeria miniata)* were pests for which nothing good could be said. On the north parklands almost the only Australian survivals were the graceful Spear Grass *(Stipa variabilis)* and the yellow-flowered liliaceous plant, *Bulbine bulbosa*, and their extent was now closely restricted. Isolation, which had lasted for tens of thousands of years, and the absence of all large grazing animals and of rabbits, had rendered the Australian flora incapable of contending with the hardier plants of other continents, and especially with those coming from countries whose climate resembled our own. The number of alien species now growing spontaneously in South Australia (including several garden escapes not yet thoroughly established) was about 450, while the native species, now almost confined to hilly and rocky country and the dry north, numbered over 2,000, but it must be remembered that the number of individual plants in foreign species was, usually, much greater than in those which are indigenous."

Dr. R. S. ROGERS said that "the Orchids in the State are represented by terrestrial forms only, the dry climate, the absence of high mountains and deep valleys being unfavourable to the growth of epiphytes. A transitional, *Dipodium punctatum*, which still has its epiphytic representatives in India and the Malayan Archipelago, occurs in the Mount Lofty Ranges. This is a leafless species, deficient or destitute of chlorophyll, and in its early stages dependent, to some extent, for its nutrition upon the roots of other plants *(e.g., Candollea)*.

"The distribution of the family is probably determined by an average annual rainfall of 10 inches, roughly represented in this State by Goyder's Line. Beyond this line no orchids have been recorded. It will thus be seen that their distribution occupies a comparatively small portion of this large State and is chiefly coastal in character. As a matter of fact, of the 106 species on our census, very few are to be found more than 100 miles north of Adelaide.

"Those which penetrate furthest into the interior belong to the genera *Pterostylis, Caladenia,* and *Thelymitra.*

"It seems remarkable that any representative of the former genera, the species of which are so specially adapted for shade and moisture, should ever acquire the physical characters necessary for existence in these comparatively arid regions.

They meet their xerophytic conditions by enlargement of their root-system thickening of their stems, withering of their leaves before flowering, and the development of rufous tints in otherwise green flowers. Hairs are not produced on the vegetative parts of the plant, and only very sparsely on the flowers themselves. The Caladenias, with their somewhat woody stems and very hairy habit, are better equipped for the rigid conditions under which they have to live, and except that they are stunted in growth maintain a hardy existence in the far north with few modifications.

"The few Thelymitras that occur in these districts increase their root-system and reduce their foliage as in the case of *Pterostylis.* In no case do they develop hairs.

"There is no doubt that the tubers of some of these plants do not vegetate annually, but remain dormant for lengthy periods during unusually dry seasons.

"Owing to the geographical position of South Australia as the Central State, it is hardly to be expected that any of its genera should be endemic. As a matter of fact, out of 20 indigenous genera, no less than 16 are shared in common with all the other States; *Dipodium, Orthoceras,* and *Spiranthes* do not extend into Western Australia, but are distributed over other parts of the continent, and the remaining one, *Leptoceras,* extends from the Swan River along the southern coast to Port Phillip, but is not recorded from Tasmania.

"In this enumeration the Northern Territory has not been included, owing to the scantiness of our knowledge of the orchidaceous flora of that region. There is, therefore, no genus which can be said to be the exclusive property of South Australia.

"Some of our genera have a wide climatic range and extend well into the Australian tropics; rather more than half of them are represented in New Zealand; about a third have been reported from the Pacific and such distant stations as the Malayan Archipelago and New Guinea; one *(Microtis)* occurs in China, and another *(Spiranthes)* which is almost cosmopolitan in many temperate and tropical regions of the globe.

"Although nearly all our genera are essentially Australian types, only three *(Glossodia, Eriochilus,* and *Leptoceras)* are peculiar to Australia. Others, such as *Pterostylis, Caladenia, Thelymitra, Prasophyllum, Diuris,* etc., with our continent as a centre of dispersion, have outlying representatives in neighbouring countries and islands; whereas a few, including *Corysanthes, Cryptostylis, Dipodium,* and possibly *Microtis,* may be regarded as Asiatic in their origin.

"Spiranthes, to which I have already referred, has probably reached us from the New World, where it is particularly rich in species in Central and South America.

"With the exception of *Dipodium,* which is the sole representative of the tribe Vandeae, all South Australian orchids belong to the Neottieae.

"By far the best developed genera are:—*Pterostylis,* with 21 species; *Caladenia,* with 20 species; *Thelymitra,* 17; *Prasophyllum,* 14; and *Diuris,* 8.

"Pterostylis, known by the vernacular name of "Greenhoods," is of special interest on account of its irritable labellum and intricate mechanism for fertilization by insects. One of its species has reached New Guinea, and others are recorded from New Caledonia and New Zealand. The *Caladenias,* popularly called "Spiders," are probably the most showy of our orchids and attract much attention, not only on account of their beauty, but also on account of their profusion. They have no very definite odour but are all cross-pollinated by insects. A small member of the genus has penetrated as far north as Java, and others are represented in New Zealand and New Caledonia.

"Thelymitra contains several very showy species, some of which are delightfully fragrant. About half of the species are entirely dependent upon insects for

their fertilization, the flowers of the others only expand on hot sunny days and are self-fertilized.

"It is well represented in New Zealand, has been recorded from the Pacific Islands, and has pushed as far north as the Philippines. *Prasophyllum*, which is usually fertilized by insects but sometimes self-pollinated, is probably the least conspicuous of our genera. Some members of the genera are exceptionally small with very minute flowers, but in Western Australia I have seen others nearly six feet high, which constitute a conspicuous feature of the landscape. In this State the latter species not infrequently attains a height of 4 feet 6 inches. As in the case of *Thelymitra*, some species are delightfully fragrant.

"*Diuris* is popularly known as 'Two-tails.' The species are all dainty and attractive and are collected in great numbers by 'flower-gatherers.' Fortunately, like the Caladenias, they are very abundant, otherwise they would soon be exterminated.

"They are entirely dependent on cross-fertilization. Some are pleasantly perfumed but the majority are without scent. It is at first rather difficult to understand that a genus so admirably adapted for dispersion, should be out-rivalled in distribution by *Thelymitra*. The reason possibly is, that the latter is more capable of adapting itself to its environment by abandoning the habit of cross-pollination and in rapidly acquiring that of self-pollination which makes it independent of any particular insect agent. A single species of *Diuris* has been recorded from Timor; otherwise the genus would appear to be restricted to Australia.

"The endemic species in this State appear to be limited to about a dozen. Their number may be still less as our knowledge increases. Species regarded as endemic a few years ago have since been discovered in other States."

Mr. J. F. Bailey said that "South Australia is not so well off in decorative species of plants as are some of the other States, those to the East embracing in their floras such ornate subjects as the Waratahs, Christmas Bells *(Blandfordia)*, Wheel of Fire *(Stenocarpus)*, Flame Trees *(Brachychiton)*, and the large-flowering terrestrial Orchids—*Phaius* and *Calanthe*; and Western Australia the Christmas Tree *(Nuytsia)*, Verticordias, Hoveas, Red and Pink Flowering Gums, Kangaroo Paws, and Leschenaultias. Our flora is also short of Tree Fern and Palms, which are sought after by horticulturists for providing landscape effects. The only representatives being *Todea barbara* among the former and *Livistona Mariae* among the latter.

"Nevertheless, we have a number that could be used in the garden, where they would hold their own with many of the imported plants, and the following have been noticed in gardens in and about Adelaide.

Iridaceae—*Orthrosanthus multiflorus* and *Patersonia glauca*.

Amarylidaceae—*Crinum pedunculatum*, the Murray Lily, and *Calostemma purpureum*.

Proteaceae—*Hakea multilineata*, *Banksia ornata*, *Grevillea lavandulacea*, and *G. ilicifolia*.

Chenopodiaceae—*Atriplex nummularia*, the Old Man Saltbush for hedges.

Capparidaceae—*Capparis Mitchellii*, Native Orange, and *C. spinosa*, the Caper-bush.

Pittosporaceae—*Pittosporum phillyreoides*, the Native Willow, and *Bursaria spinosa*, the Native Box.

Leguminoseae—*Acacia pycnantha*, the Golden Wattle; *A. dodonaeifolia*, the Port Lincoln Wattle (used for hedges); *A. decurrens*, the Black Wattle; *A. longifolia*, and *A. furnesiana*. *Cassia Sturtii*, *C. eremophila*, and *C. artemesioides*. *Templetonia retusa*, *Goodia lotifolia*, *Crotalaria Cunninghamii*, the Bird Flower; *Clianthus speciosus*, the Sturt Pea; and *Swainsona* of several species.

RUTACEAE—*Boronia Edwardsii, B. pilosa, Correa rubra,* and *C. alba.*

TREMANDRACEAE—*Tetratheca pilosa.*

MALVACEAE—*Hibiscus Huegelii, Cienfuegosia hakeifolia,* and *Gossypium Sturtii,* Sturt's Rose.

VIOLACEAE—*Viola hederaceae,* the Native Violet.

MYRTACEAE—*Leptospernum,* of several species; *Callistemon regulosus,* the Scarlet Bottle-brush; *Melaleuca squamea, M. gibbosa,* and *M. acuminata, Eucalyptus cladocalyx,* and *E. leucoxylon,* with rose-coloured flowers.

LABIATAE—*Prostanthera lasianthos* the Mintbush.

SCROPHULARIACEAE—*Veronica Derwentia,* with blue and also white blooms.

MYOPORACEAE—*Myoporum insulare,* Native Juniper or Boobialla, used for hedges; and *Eremophila alternifolia.*

GOODENIACEAE—*Scaevola aemula.*

COMPOSITAE—*Olearia grandiflora, O. pannosa,* and *O. teretifolia, Helichrysum bracteatum,* one of the "Everlastings," and *Calocephalus Brownii,* used for edging."

Professor CLELAND, referring to Mr. Black and the "Handbook of Flora of S.A.," said, "The preparation of this Handbook has clarified the position and put into the hand of all a ready means of ascertaining what species have been recorded in this State and the distribution of each. How important exact identification may be is well illustrated in the recognition, for instance, of weeds, some of which may be pests and other familiar ones innocuous. One saltbush may be good fodder and another such as *Atriplex Muelleri,* common as a garden weed in Adelaide suburbs and even growing in the University grounds, quite useless. One species may yield an economic product, as for instance *Nicotiana excelsior,* a large-leafed tobacco chewed by the natives in Central Australia, and another very like it, in this case *Nicotiana suaveolens,* be without narcotic effect. I consider Mr. Black's 'Flora of South Australia' the greatest Australian botanical work for more than fifty years. To be a systematist requires not only basal knowledge but an enormous range of practical experience and countless hours of toil. No branch of science is harder, and in these days, I am afraid, the systematic botanist is often not given his place at the top of the botanical tree—so to speak, its most precious and toothsome fruit—but is apt to be displaced by other aspects requiring a less-long apprenticeship.

"As a result of the publication of Mr. Black's Handbook a great impetus was given to collecting, as the large Appendix to the work shows the extent of the additions. As one who is a collector and has had the privilege of helping Mr. Black, I would like to say a few words on the subject of collecting. Though we are continually thinking that finality has been reached and that all species for a district have been discovered, additions even of new species continue to be made. During the period of the publishing of Black's Flora, Morialta yielded a new species of spear-grass and a new State record in *Lomandra caespitosa.*

"Some species escape observation on account of their flowering at an unusual period of the year. About 16 years or so ago, in journeying between Sydney and Adelaide, I dropped off the Melbourne Express at Coonalpyn in the early hours of the morning and had a look round. The stay was well worth while, as it yielded at least one new species, a heath *Leucopogon Clelandii,* as named by Mr. Cheel of the Botanic Gardens in Sydney. For long this remained the only record. A specimen not in flower but presumably this was recorded for Kangaroo Island, now I find it quite a widely distributed species growing in damp sandy loam with a clay bottom. It occurs near Encounter Bay, and I have just collected it in a heath near Mount Burr, and also near Bangham in the South-East. It is a May-flowering species, it being small is likely to be missed during the rest of the year. One does not look in the late Autumn as a time for flowering but several of our

Epacrids bloom in May. *Epacris impressa* is a great sight. *Styphelia exarrhena* with rather prickly leaves and white flowers is very pretty. The flowering time of a plant is often a very definite and limited period and in many cases occurs at the same time each year. This is very important as a separation by even only a few days will prevent the chance of cross-fertilization. Thus a slight mutation, causing a group of seedlings to flower a few days earlier or a few days later than the rest of the species, secures in some cases as complete isolation as separation by oceans. The new race must breed within itself, and gradually, minor variations build up what is a new species. We have had plants, isolated on islands, tend in the long run to become specifically distinct from those on the mainland. The same result may follow mutational departure from the normal flowering time. The two little grasses, *Aira caryphythus* and *A. ininata*, seem to flower at different times.

"*Eucalyptus*, as far as I can see, flowers at irregular times in many cases. An accurate record of flowering periods would be of considerable interest. What seems to me very extraordinary is that all the plants of a particular species that is in flower will be in flower together over a very wide expanse of country and in localities differing in surroundings and altitude. If *E. rostrata* (a rather shy flowerer) is in bloom, every red gum tree practically that one meets with over a very wide range will be in flower. This may even be a guide as to the identification of the species at a distance. If it is in flower it must almost certainly be such-and-such which is in bloom. As the Eucalypts flower at irregular periods, from time to time flowering periods of two species will overlap and this gives a chance for cross-fertilization. It has recently been suggested that most, if not all, of our Eucalypts and Proteaceae are really hybrids, because so many pollen grains are abortive and so much seed is sterile. I must say that I cannot follow the late Professor Lawson to the extent he implies, but true crosses do unquestionably occur, and we recently had an example, found by Mr. Julius and Mr. Pinches, of the Forestry Department, at Mount Burr, the tree being an obvious cross between *E. rostrata* and *E. ovata*."

In the discussion which followed, Professor Richardson endorsed the view expressed by Mr. Black, that the native herbaceous species of Victoria and South Australia were being gradually replaced by alien species. Prior to the settlement of Australia, the edible endemic flora was in equilibrium with a light grazing, nomadic, marsupial population. The advent of the white man with his plough, fire-stick, and his herds of grazing cattle and sheep, and incidentally his droves of rabbits, upset the age-old balance between the endemic flora and native fauna. The floristic balance of vegetation was destroyed, and a new impetus was given to competitive influences.

The domestic animals graze with an intensity far in excess of the native fauna, because the animals are confined in relatively large numbers on specific areas, whereas prior to settlement the nomadic marsupials were free to roam over the entire continent.

The most marked result of the imposition of this intensive biotic factor on native species was to cause the palatable, nutritious grasses, such as the Danthonias, Themelias, and Stipas to be eaten out and replaced by the more aggressive introduced aliens.

In the northern parklands, except on the stony dry hillsides, the native vegetation had been almost entirely replaced by such unpalatable species as *Romulea*, or by plants with a rosette habit of growth, such as *Erodium*, largely as a result of continuous heavy grazing by stock taken on agistment.

Investigations on native pastures at the Waite Institute showed that by the cutting of pasture at fortnightly intervals for two years—thus simulating intensive grazing—the native species were almost entirely replaced by exotic species.

In the arid areas the indigenous perennial species of *Kochia* and *Atriplex* were better able to compete with exotic species, but even at Koonamore, as was shown by Mr. Wood, overgrazing had led to the destruction of edible indigenous species, and the process of regeneration was exceedingly slow.

Thus the introduced species were better able to withstand the effect of the biotic factor than the indigenous species, and it seemed inevitable that in course of time, especially in the settled areas of the State, the exotic species must ultimately replace the native species.

Looking at the matter from the economic point of view, the introduction of exotic species had resulted in a great increase in stock-carrying capacity of pasture lands. In view, however, of the objectionable characteristics of many introduced species, the suggestion of Professor Cleland for some system of controlled immigration of alien species should be supported.

Ordinary Meeting, July 9, 1931.

The President (Dr. Chas. Fenner) occupied the chair and 38 members were present.

Minutes of the meeting held on June 11, 1931, were read and confirmed.

Election of Fellow.—Professor Sir Charles James Martin, Kt., C.M.G., D.Sc. A ballot was taken and Sir Chas. Martin declared elected.

The President acknowledged, with thanks, the kindness of Professor Walter Howchin in presenting to the Society two volumes, comprising 68 papers, which contained researches of the Professor in connection with the Geology of South Australia, and expressed the very deep appreciation of all the members. Sir Douglas Mawson supported the remarks of the President, and expressed his admiration for the manner in which Professor Howchin had carried out, and was still carrying out, his work. Professor Howchin thanked the President, Sir Douglas Mawson, and the Fellows for the expressions of appreciation.

The President extended a welcome to Miss Nelly Woods and Dr. Chas. Chewings as new Fellows.

Papers—

"On the Class System, Kinship, Terminology, and Marriage Regulations of the Australian Native Tribes," by H. K. Fry, B.Sc., M.B., B.S.

"Notes on Some Miscellaneous Coleoptera," by Arthur M. Lea, F.E.S.

Discussion on Mr. N. B. Tindale's paper, "Geological Notes on the Iliaura Country, Central Australia." Mr. Tindale gave a brief geological description of the country embodied in the paper, which was presented at the last Ordinary Meeting of the Society, and taken as read. Professor Howchin drew attention to the fact that the paper proved the existence of Ordovician beds a considerable distance farther north-easterly than previously recorded, namely, to the north and east of the MacDonnell Ranges.

Sir Douglas Mawson and Mr. Madigan also took part in the discussion.

The President then expressed the pleasure of the Fellows at the presence of one of the most distinguished Fellows of the Society, Sir Douglas Mawson, and congratulated him on the success of his two expeditions to the Antarctic. Sir Douglas Mawson thanked the President and Fellows for their expressions of goodwill.

Exhibits.—After reading his paper, Mr. Lea exhibited some buffalo flies from North Australia, where they are seriously troublesome to cattle; also a remarkable fly from Sydney, which is parasitic upon cockchafer beetles; and some stag flies from Papua, with horns on the head of the males like those of stags. Sir Douglas Mawson made a few introductory remarks in connection with the finding of Meteoric Iron in Central Australia, the details of which were then explained

by Mr. A. R. ALDERMAN, who said that the specimens exhibited were some of the 800 odd collected around the twelve or thirteen meteoric craters at Henbury Station, Central Australia. The largest crater is oval in shape and 200 yards long and 50-60 feet deep. This crater is second only in size to the great crater at Canyon Diablo, Arizona. After the discussion which followed, the President formally thanked Mr. Alderman for his exhibit. Mr. H. H. FINLAYSON exhibited and made some remarks upon parts of a steel trap which had been chewed by a large male Tasmanian Devil, *Sarcophilus harrisi*, which was taken by him in western Tasmania. The skull of the animal was shown, also some of the stomach contents which included part of a ·303 bullet ingested with a wallaby carcase used for bait. Dr. WM. CHRISTIE exhibited some leaves preserved in Bailey's solution (glycerine 1 and water 4), and a series of pictures of plants and flowers drawn by pupils in the State schools who were affected by colour blindness. THE PRESIDENT exhibited fossil leaves of *Magnolia* and Laurel obtained from Baker's Gully in the Mount Lofty Ranges. Mr. C. T. MADIGAN exhibited geological specimens of Archaeocyathinae limestone from the MacDonnell Ranges (River Ross), which was the first discovery of this Cambrian fauna in Central Australia; also some Cryptozoön limestone from Central Australia, and some large crystals of mica, tourmaline, felspar, sargenitic quartz (tourmaline needles in quartz), and garnet from Harts Range, Central Australia.

Professor T. HARVEY JOHNSTON then expressed the very best wishes of the Fellows to the President, on a safe, happy, and successful journey to England, where Dr. Fenner would be attending various scientific functions as the representative of this and other societies in Australia. The President thanked the Fellows for the expressions of goodwill and kind remarks.

ORDINARY MEETING, AUGUST 13, 1931.

THE JUNIOR VICE-PRESIDENT (Professor J. A. Prescott) occupied the chair and 29 members and visitors were present.

Minutes of the meeting held on July 9, 1931, were read and confirmed.

THE CHAIRMAN apologized for the absence of the President (Dr. Chas. Fenner) who was proceeding overseas to attend various scientific celebrations, and the senior Vice-President (Professor T. Harvey Johnston) who was in Central Australia with the Adelaide University Anthropological Expedition.

THE CHAIRMAN informed the members that he was very pleased to be able to state that the services of Mr. J. F. Bailey would still be retained by this State at the Botanic Gardens, and also as a member of Council of this Society.

Professor PRESCOTT then asked that consideration be given to making an Award of the Sir Joseph Verco Medal for 1931, and submitted the name of Sir Douglas Mawson as the only recommendation from the Council. Professor Prescott gave a brief account of the high qualifications held by Sir Douglas, his contributions to the knowledge of the Geology of this State, and his important exploration work in the Antarctic. Mr. J. M. Black formally moved, and Mr. B. S. Roach seconded, that the recommendation of the Council be confirmed.—Carried.

NOMINATIONS AS FELLOWS.—Oscar Westcott Frewin, M.B., B.S., medical practitioner, Hindmarsh, and John Matthew Dwyer, M.B., B.S., medical practitioner, Adelaide Hospital, were read.

PAPERS—

"A Study of the Vegetation of the Lake Torrens Plateau, South Australia," by (Miss) B. JEAN MURRAY, B.Sc., communicated by J. G. Wood, M.Sc.

Mr. J. M. Black, Mr. C. T. Madigan, Mr. W. Weidenbach, Mr. E. H. Ising, and Professor J. A. Prescott took part in the discussion of the paper.

"Atmospheric Saturation Deficit in Australia," by Professor J. A. PRESCOTT, M.Sc., A.I.C.

Mr. Edwin Ashby and Mr. J. G. Wood took part in the discussion which followed.

Mr. EDWIN ASHBY then delivered an instructive and interesting lecture on "The Evolution of Chitons," illustrated by drawings and lantern slides. At the conclusion the Chairman expressed the thanks of the members to the lecturer.

SPECIAL MEETING, SEPTEMBER 10, 1931, AT 7.45 P.M.

THE SENIOR VICE-PRESIDENT (Professor T. Harvey Johnston) occupied the chair and 25 members were present.

Consideration was given to the Amended Rules and By-laws of the Society as recommended by the Council, a copy of which had been sent to all members resident in the State.

Further amendments were made to:—

Rules—Number 23 and 28.
By-laws—V. No. 1, Library Committee.
VI. No. 3, Meetings of Society.
VII. Nos. 6 and 12, Papers.

Mr. Roach then moved, and Professor Prescott seconded, that the Rules and By-laws be adopted.—Carried.

ORDINARY MEETING, SEPTEMBER 10, 1931, AT 8.5 P.M.

THE SENIOR VICE-PRESIDENT (Professor T. Harvey Johnston) occupied the chair and 51 members and visitors were present.

Mr. B. S. ROACH declared that he had read the Minutes of the Ordinary Meeting, held August 13, 1931, and could certify that they constituted a correct record, and moved that they be taken as read. Professor J. A. PRESCOTT seconded the motion, which was carried.

ELECTION OF FELLOWS.—Oscar Westcott Frewin, M.B., B.S., medical practitioner, Hindmarsh, and John Matthew Dwyer, M.B., B.S., medical practitioner, Adelaide Hospital. A ballot was taken and Dr. Frewin and Dr. Dwyer were declared elected.

At 8.15 p.m. the Patron of the Society, His Excellency the Governor, Brig.-General the Hon. A. A. Hore-Ruthven, V.C., K.C.M.G., C.B., D.S.O., was warmly welcomed by the Chairman.

Professor T. HARVEY JOHNSTON expressed the delight of the Fellows at the presence of Sir Wm. Mitchell and Naval Lieut. K. Oom, who was cartographer on the "Discovery."

Professor HARVEY JOHNSTON extended a warm welcome to Lady Mawson, and then read letters of apology from Sir George Murray and Sir Joseph Verco.

THE CHAIRMAN then addressed the members as follows:—

"Tonight the Royal Society of South Australia has met to offer one of its members the highest honour that it has in its power to confer, and by so doing feels that it is also honouring itself by adding so illustrious a name as that of Sir Douglas Mawson to its roll of the recipients of the Verco Medal. This award, which commemorates the name of Sir Joseph Verco who devoted so much of his time, talent, and substance to furthering the interests of our Society, has been bestowed twice previously, namely, to our veteran geologist, Professor W. Howchin, and to our distinguished botanist, Mr. J. M. Black.

"The absence of our President who is on a visit to England to attend the meeting of the British Science Association, has placed on me, as Senior Vice-

President, the duty of eulogizing Sir Douglas Mawson before I call upon His Excellency to make the presentation. It is perhaps appropriate that this privilege has fallen on me, firstly because I have known Sir Douglas for a longer period than most of the members, since we were fellow-students in Science in Sydney University twenty-seven years ago; secondly, because we are colleagues in the University of Adelaide; thirdly, because it has been my privilege to accompany him as a member of the two recent expeditions to the Antarctic in the 'Discovery,' and to visit with him the scene of some of his former hardships and triumphs.

"Mawson's fame as an explorer and geographer is so great that one is apt to overlook his fine record of physical, geological, and mineralogical research work. Our Memoirs and Transactions for the past quarter of a century contain many of his papers relating to the structure of Central and South Australia, while numerous papers have appeared in British and American Journals. His earliest expedition was one to study the geology of the New Hebrides, in 1903. Soon afterwards he was appointed to the geological staff of the Adelaide University. His first experience of polar conditions was obtained as a member of Shackleton's British Antarctic Expedition (1907-9) in which, in company with his teacher, Professor (now Sir Edgeworth) David (also a member of our Society), and Dr. Mackay, he made the first ascent of Mount Erebus (13,350 feet), and, later, discovered the South Magnetic Pole, the accounts of these two journeys, as given in 'The Heart of the Antarctic,' making thrilling reading. Dr. H. R. Mill, in his 'Life of Sir Ernest Shackleton,' in referring to the work of David and Mawson on those occasions, said that they 'proved themselves to be worthy to rank with the foremost polar explorers of all time.' Professor David, in his account of the South Magnetic Polar journey, wrote of Mawson:—'He had throughout the whole journey showed excellent capacity for leadership, fully justifying the opinion held of him by Lieut. Shackleton when providing in my instructions from him that, in the event of anything happening to myself, Mawson was to assume leadership.'

"The experience gained in that expedition was fully utilized when Mawson planned the Australian Antarctic Expedition which carried out such excellent work during the years 1911 to 1914, contemporaneously with the last Scott ('Terra Nova') Expedition and Amundsen's bold dash to the South Pole. Gordon Hayes, in his book 'Antarctica,' makes frequent reference to the character and work of Mawson's Expedition, and I take the liberty of quoting his words. He stressed the fact that seventeen University men were included in the personnel of 'the finest expedition that ever sailed to either of the polar regions.' '. . . . The British were only feeling their way into Antarctica and serving their novitiate in its exploration until Sir Douglas Mawson's Expedition.' 'Mawson's Expedition may be held up . . . as a model for others to copy.' Its excellence lay in its design, its scope and its executive success; and it owes its exalted position amongst other expeditions mainly to the fact that it was originated and conducted by scientists of administrative ability.' . . . 'The results of Mawson's Expedition bear a closer resemblance to the splendid pioneering of Admiral Ross than that of any other Antarctic Exploration.' 'Mawson's results far exceed all others (*i.e.*, Amundsen's, Scott's two, Shackleton's) because he made the greatest inroad into the unknown with the finest scientific staff. . . . No other expedition equals the Australasian one in the wealth and importance of the data collected and in results generally.' No less than 1,500 miles of coast line were discovered in the windiest country in the world, aptly termed 'The Home of the Blizzard.' New seas were explored and huge biological and geological collections made.

"His tragic experiences in his far eastern journey, so simply told in his diary and recorded in his book, are known to all of us—the loss of Ninnis and most of the dogs and food down an enormous crevasse, and then the death of Mertz, and

the long, dangerous, solitary journey which led Mawson back, worn and starved, to safety just in time to see the relief ship disappearing in the distance. Hayes, in referring to Mawson's action regarding Mertz, says, 'This is one of the finest examples of heroism that even the exploration of Antarctica has produced.' . . . 'The moral effect of this second fatality must have been dreadful. One Antarctic explorer told the author that he was doubtful whether any other man but Mawson would have survived the ordeal. Nearly every factor of hardship incidental to polar travel had to be endured. . . . His only hope was that if he could get near enough to the Base, his diary might be discovered with his body, and thus the discoveries made by his party would not be lost.'

"During the last 'Discovery' Expedition we visited Cape Denison, and as I stood at the foot of the cross and read the inscription: 'Erected to commemorate the supreme sacrifice made by Lieut. B. E. S. Ninnis and Dr. X. Mertz in the cause of Science. A. A. E., 1913,' I tried to imagine what the feelings of Sir Douglas must have been as past events recalled themselves to his memory during the few days of our sojourn in that blizzard-swept region.

"The call of the 'Great White South' was responded to again, and after years of preparatory work, the B.A.N.Z.A.R.E. (British, Australian and New Zealand Antarctic Research Expedition) was launched, Scott's old ship, the 'Discovery,' being made available for extensive exploration and oceanographic work in the Antarctic and Subantarctic, I believe that the results, when published, will indicate that the two voyages, 1929-1930 and 1930-31, have resulted in the exploration of a much greater length of the Antarctic coastline and a more intensive oceanographic study of the two Antarctic waters than has been accomplished by any other expedition to date, and the credit of this is due, primarily, to Sir Douglas Mawson's leadership, organising ability, wide experience, his knowledge of men, and his appreciation of scientific team work. He has received many well-deserved honours. His Majesty has conferred on him Knighthood as well as the O.B.E., and the Polar Medal (with two bars). He has also received the Order of the Crown of Italy, and the Order of St. Maurice and St. Lazarus, another Italian decoration. The Royal Society of London elected him a F.R.S. The Royal Geographic Society of London awarded him a special medal struck for the Shackleton Expedition, and in 1914 the Founder's Medal for his work in the Australian Expedition.

"Other medals awarded to him for his geographical and geological work, were the Livingstone Medal of the American Geographical Society; the Helen Cuver Medal of the Chicago Geographical Society; the gold medal of the Geographical Society of Paris; the Nachtigal Medal of the Berlin Geographical Society; the Bigsby Medal of the Geological Society of London (for general geological research work); the Mueller Memorial Medal of the Australasian Association for the Advancement of Science; the Founder's Medal of the Royal Geographical Society of Australia (Queensland Branch); and now our Society desires to add the Sir Joseph Verco Medal for research to the other nine already received by our distinguished Past President, Professor Sir Douglas Mawson, who, we all hope, will live long to enjoy his well-earned distinctions and to pursue with unabated zeal his researches into the hidden mysteries of Nature and Science.'

"I have much pleasure in inviting our esteemed Patron, His Excellency the Governor, to make the presentation on behalf of the members of the Royal Society of South Australia."

His Excellency the Governor, on presenting the medal to Sir Douglas Mawson, paid a glowing tribute to his qualifications as a Leader of Men, and as a Scientist.

Sir Douglas Mawson, in acknowledging the medal, said he was deeply sensible of the honour conferred on him. He stressed the importance of having

the right men on the expeditions, and said the success of the expeditions was due to the type of men who made the voyage.

Mr. N. B. TINDALE exhibited a series of seventeen plaster casts of faces and busts of Central Australian aborigines. The impressions for these were made by Mr. H. M. Hale and himself at Cockatoo Creek, 150 miles north-west of Alice Springs, during the Adelaide University and Museum Anthropological Expedition, August, 1931. Members of both sexes of the Ilpirra, Anmatjera, Ngalia, and Aranda tribes, between the approximate ages of 12 and 65 years, were represented. The bush natives proved to be excellent subjects, and displayed marked self-control and confidence throughout the operations. The methods employed are similar to those practiced by Dr. V. Suk, of Czeco-Slovakia, and others; the eyes remaining open during the whole proceedings. Improvements in technique have been devised which permit the obtaining of a complete mould of both sides of the face and neck in one operation. The data obtained during the anthropometric examinations enable the eyes and skin colour to be matched in the completed casts. Professor Cleland, Dr. Campbell, and the Chairman took part in the discussion which followed.

PAPERS—

"The Dead Rivers of South Australia, Part I., The Western Group," by Professor WALTER HOWCHIN, F.G.S., who illustrated his remarks with maps and diagrams. Sir Douglas Mawson, Mr. Madigan, and Dr. Chewings discussed Professor Howchin's paper. The Chairman extended the thanks of those present to Professor Howchin for his interesting remarks.

"The Mammals of the Dawson Valley, Queensland, Part I.," by H. H. FINLAYSON. It was moved by Professor J. A. Prescott, seconded by Mr. B. S. Roach, that the paper be taken as read.

ANNUAL MEETING, OCTOBER 8, 1931.

THE SENIOR VICE-PRESIDENT (Professor T. Harvey Johnston) occupied the Chair and 42 members and visitors were present.

Minutes of the Special and Ordinary Meetings, held September 10, 1931, were read and confirmed.

Mr. B. S. ROACH referred to the loss sustained by the death of Sir John Monash and moved that a wreath and the following telegram be sent: "With the deepest sympathy and in admiration for the career of a great Australian citizen, renowned in war and distinguished in applied science. This wreath is forwarded by the Royal Society of South Australia." The motion was seconded by Dr. L. Keith Ward and carried by the Fellows standing in silence for a few minutes.

THE CHAIRMAN heartily congratulated Professor J. A. Prescott on behalf of the Fellows on having been awarded the Henry George Smith Medal by the Australian Chemical Institute for his researches in Applied Chemistry.

THE SECRETARY read the Annual Report of the Council for the year ended September 30th, 1931. It was moved by Mr. Selway, seconded by Professor Cleland, that the Report be received and adopted.—Carried

THE TREASURER presented the Financial Statement for the year ended September 30, 1931, and moved that it be received and adopted. Seconded by Mr. Selway and carried.

THE CHAIRMAN extended a welcome to Dr. John M. Dwyer as a new Fellow.

THE CHAIRMAN then drew attention to the valuable services rendered to the Society by the Honorary Editor, Treasurer, and Secretary.

Professor PRESCOTT moved, and Mr. BAILEY seconded, that the appreciation of the Fellows for the services rendered by those Officers be recorded in the Minutes.—Carried.

The following Officers and Members of Council were elected for the year 1931-32:—President, Professor T. Harvey Johnston, M.A., D.Sc.; Vice-Presidents, Professor J. A. Prescott, M.Sc., A.I.C., and Mr. J. M. Black; Editor, Professor Walter Howchin, F.G.S.; Treasurer, B. S. Roach; Secretary, Ralph W. Segnit, M.A., B.Sc.; Members of Council, Sir Joseph C. Verco, M.D., F.R.C.S., T. D. Campbell, D.D.Sc., Herbert M. Hale; Auditors, W. C. Hackett and O. Glastonbury.

PAPERS—

"Pollination of *Caladenia deformis* R. Br.," by R. S. ROGERS, M.A., M.D.

"Additions to the Flora of South Australia, No. 29," by J. M. BLACK.

"Australian Fungi, Notes and Descriptions, No. 8," by Professor J. B. CLELAND, M.D.

"Notes on Some South and Central Australian Mammals, Part II.," by H. H. FINLAYSON.

"Pelecypoda obtained from the Abattoirs Bore," by Nelly Hooper Woods, M.A.

"Petrographic Notes on Some Basic Rocks from the Mount Barker and Woodside Districts," by A. R. ALDERMAN, M.Sc., F.G.S.

EXHIBITS.—Dr. L. KEITH WARD exhibited "Widmanstatten" Figures on the Henbury Meteoric Iron, and said that when a polished surface of a meteoric iron is etched by immersion for a few minutes in dilute nitric acid, markings are produced which are named after the German chemist who first brought them to notice. The markings are composed of interlocking plates of nickel-iron alloys, known as kamacite—and taenite, with the interstices filled by an entectic mixture termed plessite. The proportion of iron to nickel in kamacite ranges from 13:1 to 18:1, and in taenite from 1:1 to 7:1. The "Widmanstatten" figures are the result of the differences in the solubility of the alloys in acid. Mr. A. G. EDQUIST exhibited some wattle seedlings of the species *Acacia decurrens* grown from seeds that had been boiled for various times, extending from 25 to 40 minutes.

ANNUAL REPORT

FOR THE YEAR ENDED SEPTEMBER 30, 1931.

The average attendance of Fellows at the meetings held during the year has been 36.

The Patron of the Society, His Excellency the Governor Brig.-General the Hon. A. A. Hore-Ruthven, V.C., K.C.M.G., C.B., D.S.O., paid an official visit to the Society at the Ordinary Meeting held in September.

The President, Dr. Charles A. E. Fenner, left Australia for England early in August to attend the Centenary Meeting of the British Association for the Advancement of Science. and the Clerk Maxwell Celebrations at Cambridge, as the Representative Delegate of this Society, and the best wishes of the Fellows were extended to him for a happy and successful voyage.

The Senior Vice-President, Professor T. Harvey Johnston, and on one occasion the Junior Vice-President, Professor J. A. Prescott, acted as Chairmen during the absence of the President.

Professor Sir Douglas Mawson, a past President of the Society, was awarded the Sir Joseph Verco Medal for 1931, which was handed to him by the Patron.

Professor Walter Howchin received the congratulations of the Society on the completion and publication of Part III., "The Building of Australia and the Succession of Life."

Professor Sir Douglas Mawson and Professor T. Harvey Johnston were welcomed and congratulated by the Society on their safe return from the second phase of the Antarctic Expedition.

Professor Kerr Grant was elected as the Representative of the Society to the Faraday Celebrations at Cambridge.

Dr. A. Lewis was elected as the Representative Delegate of the Society to the 400th Centenary Celebrations of the College of France at Paris.

Sir William Bragg, an Honorary Fellow of the Society, received the congratulations of the Fellows on having had the distinguished honour of the Order of Merit conferred upon him.

Sir Horace Lamb, a past President of the Society, was congratulated on having had the distinction of Knighthood conferred upon him.

During the year two of the Ordinary Meetings of the Society were devoted to special subjects in the form of a series of lectures, which were largely attended. The first was a "General Discussion on Laterite and Lateritic Soils," introduced by Professor J. A. Prescott, who was assisted by Mr. R. J. Best, Mr. J. G. Wood, Mr. C. T. Madigan, and Dr. R. Lockhart Jack. The second consisted of a series of lecturettes on "The Status of the Native Flora of South Australia," at which the following Fellows contributed short lectures:—Mr. J. M. Black, Dr. R. S. Rogers, Mr. J. F. Bailey, Mr. J. G. Wood, Dr. Robert Pulleine, and Professor J. B. Cleland.

At the Ordinary Meeting held in August, Mr. Edwin Ashby delivered an interesting lecture on "The Evolution of Chitons."

During the year the Rules and By-laws of the Society have been revised and amended.

Papers:—

Geological papers were contributed by Dr. Chas. Chewings, Mr. N. B. Tindale, Professor Walter Howchin, Mr. A. R. Alderman, and Miss N. H. Woods.

Zoological papers were read by Mrs. Effie W. Best, Mr. Arthur M. Lea, and Mr. H. H. Finlayson.

Botanical papers were presented by Miss B. Jean Murray (communicated by Mr. J. G. Wood), Dr. R. S. Rogers, Mr. J. M. Black, and Prof. J. B. Cleland.

Two Anthropological papers were read by Dr. H. K. Fry.

A Meteorological paper was contributed by Professor J. A. Prescott.

The Membership of the Society shows a slight increase, the number of Fellows elected during the year being 11. Seven Fellows resigned, and one died. The Membership roll at the close of the year is as follows:—Honorary Fellows, 5; Fellows, 166; Associates, 1. Total, 172.

During the year the Society has suffered loss by death of one Fellow, namely, Dr. Thomas James, who was elected a Fellow in 1893.

The Council has met on 12 occasions, of which 3 were special meetings, the attendance being as follows:—

Dr. Charles Fenner, 9; Professor T. Harvey Johnston, 8; Professor J. A. Prescott, 7; Mr. Ralph W. Segnit, 12; Mr. B. S. Roach, 12; Professor Walter Howchin, 12; Sir Joseph C. Verco, 0; Dr. T. D. Campbell, 7; Mr. J. M. Black, 9; Mr. J. F. Bailey, 11; Mr. Arthur M. Lea, 11; Mr. C. T. Madigan, 7.

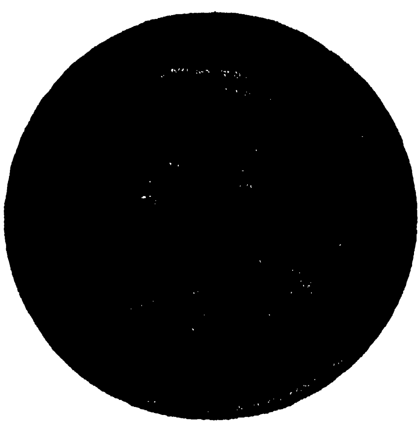
The President was absent from two meetings whilst attending Science celebrations in England as a Representative Delegate of this Society. Professor T. Harvey Johnston was away from two meetings, due to his absence from the State in connection with the Antarctic Expedition, and was in the interior of Australia

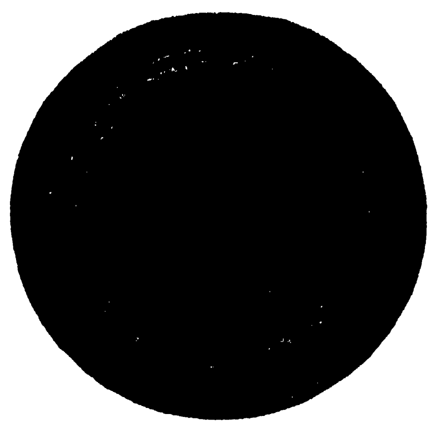
during the August meeting. Professor J. A. Prescott was granted leave of absence from three meetings to attend Science meetings in Melbourne and Tasmania. Dr. T. D. Campbell was in the interior of Australia during the August meeting. Mr. J. M. Black was granted leave of absence from two meetings to visit England and the Continent. Mr. J. F. Bailey was granted leave of absence in March to visit Victoria. Mr. C. T. Madigan was absent from two meetings whilst in Central Australia.

CHAS. A. E. FENNER, *President.*
RALPH W. SEGNIT, *Secretary.*

THE SIR JOSEPH VERCO MEDAL.

The Council, on August 23, 1928, having resolved to recommend to the Fellows of the Society that a medal should be founded to give honorary distinction for scientific research, and that it should be designated the Sir Joseph Verco Medal, was submitted to the Society at the evening meeting of October 11, 1928,





and at a later meeting, held on November 8, 1928, when the recommendation of the Council was confirmed on the following terms:—

REGULATIONS.

XI.—The medal shall be of bronze, and shall be known as the Sir Joseph Verco Medal, in recognition of the important service that gentleman has rendered to the Royal Society of South Australia. On the obverse side of the medal shall be these words: 'The Sir Joseph Verco Medal of the Royal Society of South Australia,' surrounding the modelled portrait of Sir Joseph Verco, while on the reverse side of the medal there shall be a surrounding wreath of eucalypt, with the words: 'Awarded to.......................................for Research in Science,' the name of the recipient, and the year of the award. The Council shall select the person to whom it is suggested that the medal shall be awarded, and that name shall be submitted to the Fellows at an Ordinary Meeting to confirm, or otherwise, the selection of the Council, by ballot or show of hands. The medal shall be awarded for distinguished scientific work published by a Member of the Royal Society of South Australia."

ROYAL SOCIETY OF SOUTH AUSTRALIA (INCORPORATED).

Receipts and Payments for the Year ended September 30, 1931.

RECEIPTS.

	£ s. d.	£ s. d.
To Balance, October 1, 1930		743 12 6
„ Subscriptions	152 10 0	
„ Field Naturalists' Section	32 0 0	
		184 10 0
„ Use of Room and Lantern by other Societies	6 9 6	
„ Sale of Publications and Exchange	10 8 2	
		16 17 8
„ Interest—		
Savings Bank Account	28 19 7	
Transferred from Endowment Fund	184 2 2	
		213 1 9
		£1,158 1 11

PAYMENTS.

	£ s. d.	£ s. d.
By Transactions—		
Printing	214 11 8	
Illustrating	51 15 1	
Publishing	10 0 4	
		276 7 1
„ Library—		
Librarian	41 12 6	
Customs Duties	9 0 0	
		50 12 6
„ Sundries—		
Cleaning and Lighting	8 16 8	
Printing, Postages and Stationery	21 10 2	
Insurance	6 15 0	
		37 1 10
„ Grant to Field Naturalists' Section		65 15 0
„ Balance, September 30, 1931—		
Savings Bank of South Australia	617 13 8	
The Bank of Australasia	110 11 10	
		728 5 6
		£1,158 1 11

Audited and found correct,

W. CHAMPION HACKETT } Hon.
O. GLASTONBURY, A.A.I.S., A.F.I.A. } Auditors.

B. S. ROACH, Hon. Treasurer.

Adelaide, October 3, 1931.

ROYAL SOCIETY OF SOUTH AUSTRALIA (INCORPORATED).

ENDOWMENT FUND.

As at September 30, 1931.

(Capital £4,069 6 10d.)

	£ s. d.	£ s. d.		£ s. d.	£ s. d.
1930—October 1.			1931—September 30.		
To Balance, S.A. Government Stock	4,064 18 9		By Revenue Account . .		184 2 2
Savings Bank	4 8 1	4,069 6 10	„ S.A. Government Inscribed Stock at Cost . .	4,064 18 9	
„ Interest Received		184 2 2	„ Savings Bank Account . .	4 8 1	4,069 6 10
		£4,253 9 0			£4,253 9 0

Application has been made to convert the S.A. Government Stock into the National Debt Conversion Loan.

Audited and found correct,

W. CHAMPION HACKETT
O. GLASTONBURY, A.A.I.S., A.F.I.A. } Hon. Auditors.

B. S. ROACH, Hon. Treasurer.

Adelaide, October 3, 1931.

THE ENDOWMENT AND SCIENTIFIC RESEARCH FUND.

1902.—On the motion of the late Samuel Dixon it was resolved that steps be taken for the incorporation of the Society and the establishment of an Endowment and Scientific Research Fund. Vol. xxvi., pp. 327-8.

1903.—The incorporation of the Society was duly effected and announced. Vol. xxvii., pp. 314-5.

1905.—The President (Dr. J. C. Verco) offered to give £1,000 to the Fund on certain conditions. Vol. xxix., p. 339.

1929.—The following are particulars of the contributions received and other sources of revenue in support of the Fund up to date:—

SUMMARY OF THE ENDOWMENT FUND.

(Capital £4,069 6s. 10d.)

Contributions.

	£	s.	d.	£	s.	d	£	s.	d
Donations—									
1908, Dr. J. C. Verco	1,000	0	0						
1908, Thomas Scarfe	1,000	0	0						
1911, Dr. Verco	150	0	0						
1913, Dr. Verco	120	0	0						
Mrs. Ellen Peterswald	100	0	0						
Small Sums	6	0	0						
				2,376	0	0			
Bequests—									
1917, R. Barr Smith	1,005	16	8						
1920, Sir Edwin Smith	200	0	0						
				1,205	16	8			
Life Members' Subscriptions				225	0	0			
*Interest and Discounts				156	3	10			
From Current Account				106	6	4			
							4,069	6	10

*Interest on investments has, in the main, been transferred to general revenue for the publication of scientific papers. See Balance-sheets.

GRANTS MADE IN AID OF SCIENTIFIC RESEARCH.

1916, G. H. Hardy, "Investigations into the Flight of Birds"	15	0	0
1916, Miss H. A. Rennie, "Biology of *Lobelia gibbosa*"	2	2	0
1921, F. R. Marston, "Possibility of obtaining from Azine precipitate samples of pure Proteolytic Enzymes"	30	0	0
1921, Prof. Wood Jones, "Investigations of the Fauna and Flora of Nuyts Archipelago"	44	16	7

ROYAL SOCIETY LIBRARY.

List of Governments, Societies and Editors with whom Exchanges of Publications are made.

AUSTRALIA.

Australasian Institute of Mining and Metallurgy, Melbourne.
Bureau of Census and Statistics, Canberra.
Council for Scientific and Industrial Research, Melbourne.

SOUTH AUSTRALIA.

Botanic Garden, Adelaide.
Mines Department, Adelaide.
Public Library, Museum, and Art Gallery of South Australia.
Royal Geographical Society of Australasia (S.A. Branch).
South Australian Institutes Association, Adelaide.
South Australian Museum, Adelaide.
South Australian Naturalist, Adelaide.
South Australian Ornithologist, Adelaide.
South Australian Parliamentary Library.
University of Adelaide.
Waite Agricultural Research Institute, Glen Osmond.

NEW SOUTH WALES.

Australian Museum, Sydney.
Botanic Gardens, Sydney.
Department of Agriculture, Sydney.
Linnean Society of New South Wales.
Mines Department, Sydney.
Public Library of New South Wales.
Royal Society of New South Wales.
Royal Zoological Society of New South Wales.
School of Public Health and Tropical Medicine, Sydney.
Technological Museum, Sydney.
University of Sydney.

QUEENSLAND.

Department of Agriculture, Brisbane.
Geological Survey, Brisbane.
Queensland Museum, Brisbane.
Public Library of Queensland, Brisbane.
Royal Society of Queensland, Brisbane.
University of Queensland, Brisbane.

TASMANIA.

Government Geologist, Mines Department, Hobart.
Public Library of Tasmania, Hobart.
Royal Society of Tasmania, Hobart.
University of Tasmania, Hobart.

VICTORIA.

Field Naturalists' Club of Victoria, Melbourne.
Government Botanist, National Herbarium, Melbourne.
Mines Department, Melbourne.
National Museum, Melbourne.
Public Library of Victoria, Melbourne.
Royal Society of Victoria, Melbourne.
University of Melbourne.

WESTERN AUSTRALIA.

Geological Survey Department, Perth.
Public Library of Western Australia, Perth.
Royal Society of Western Australia, Perth.
University of Western Australia, Perth.

ENGLAND.

British Museum Library, London.
British Museum (Natural History), South Kensington.
Cambridge Philosophical Society.
Cambridge University Library.
Conchological Society of Great Britain and Ireland.
Entomological Society of London.
Geological Society of London.
Geologists' Association, London.
Hill Museum, Witley, Surrey.
Imperial Institute, South Kensington.
Imperial Institute of Entomology, London.
Linnean Society of London.
Liverpool Biological Society.
Manchester Literary and Philosophical Society.
National Physical Laboratory, Teddington.
Rhodes House Library, Oxford.
Rothamsted Experimental Station, Harpenden.
Royal Botanic Gardens, Kew.
Royal Empire Society, London.
Royal Geographical Society, London.
Royal Microscopical Society, London.
Royal Society, London.
Science Museum, South Kensington.
Zoological Museum, Tring, Herts.
Zoological Society of London.

SCOTLAND.

Edinburgh Geological Society.
Geological Society of Glasgow.
Royal Society of Edinburgh.

IRELAND.

Royal Dublin Society.
Royal Irish Academy, Dublin.

AUSTRIA.

Akademie der Wissenschaften, Vienna.
Geologische Bundesanstalt, Vienna.
Naturhistorische Museums, Vienna.
Zoologisch-Botanische Gesellschaft, Vienna.

BELGIUM.

Académie Royale de Belgique, Brussels.
Instituts Solvay, Brussels.
Musée Royale d'Histoire Naturelle de Belgique, Brussels.
Société Entomologique de Belgique, Ghent.
Société Royale de Botanique de Belgique, Brussels.
Société Royale des Sciences de Liège.
Société Royale Zoologique de Belgique, Brussels.

BRAZIL.

Instituto Oswaldo Cruz, Rio de Janeiro.
Museu Paulista, Sao Paulo.

CANADA.

Canadian Geological Survey, Ottawa.
National Research Council of Canada, Ottawa.
Nova Scotian Institute of Science, Halifax.
Royal Canadian Institute, Toronto.
Royal Society of Canada, Ottawa.
University of British Columbia, Vancouver.

CHINA.

Geological Survey of China, Peiping.
Institute of Biology, National Library of Peiping.

CZECHO-SLOVAKIA.

Ceskoslovenska Botanicka Spolecnost, Prague.

DENMARK.

Conseil Permanent International pour l'Exploration de la Mer.
Danske Naturhistorisk Forening. Copenhagen.
Kobenhavn Universitets Zoologiske Museum.
K. Danske Videnskabernes Selskabs. Copenhagen.

FINLAND.

Societas Entomologica Helsingforsiensis.
Societas Scientiarum Fennica, Helsingfors.

FRANCE.

Muséum National d'Histoire Naturelle, Paris.
Société des Sciences Naturelles de l'Ouest de la France, Nantes.
Société Entomologique de France, Paris.
Société Géologique de France, Paris.
Société Linnéenne de Bordeaux.
Societe Linnéenne de Normandie, Caen.

GERMANY.

Bayerische Akademie der Wissenschaften zu München.
Berliner Gesellschaft für Anthropologie, Ethnologie, und Urgeschichte.
Bibliothek der Botanischen Gartens und Museums, Berlin.
Fedde, F.: Repertorium specierum novarum regni vegetabilis, Berlin.
Gesellschaft der Wissenschaften zu Göttingen.
Gesellschaft für Erdkunde zu Berlin.
K. Leopoldinische Deutsche Akademie de Naturforscher, Halle.
Naturforschende Gesellschaft, Freiburg.
Preussische Akademie der Wissenschaften, Berlin.
Senckenbergische Bibliothek, Frankfürt a. M.
Zoologische Museum der Universitat, Berlin.
Zoologische Staatsinstitut und Zoologische Museum, Hamburg.

HAWAIIAN ISLANDS.

Bernice Pauahi Bishop Museum, Honolulu.
Hawaiian Entomological Society, Honolulu.

HOLLAND.

Musée Teyler, Harlem.
Rijks Herbarium, Leiden.

HUNGARY.

Musée National Hongrois, Budapest.

INDIA.

Colombo Museum.
Government Museum, Madras.
Geological Survey of India, Calcutta.
Royal Asiatic Society, Bombay Branch and Malayan Br.
Zoological Survey of India, Calcutta.

ITALY.

Laboratoria di Entomologia, Bologna.
Laboratoria di Zoologia Generale e Agraria, Portici.
Società di Scienze Naturali ed Economiche, Palermo.
Società Entomologica Italiana, Genova.
Società Italiana di Scienze Naturali, Milano.
Società Toscana di Scienze Naturali, Pisa.

JAPAN.

Hiroshima University.
Kyōto Imperial University.
Taihoku Imperial University.
Tokyo Imperial University.

MEXICO.

Instituto Geológico de Mexico.
Sociedad Cientifica "Antonio Alzate," Mexico.

NEW ZEALAND.

Auckland Institute and Museum.
Dominion Museum, Wellington.
New Zealand Institute, Wellington.
Otago University Museum, Dunedin.
Philosophical Institute of Canterbury, Christchurch.

NORWAY.

Bergens Museum, Bergen.
Kongelige Norske Videnskabers Selskabs, Trondheim.
Tromso Museum.

PHILIPPINE ISLANDS.

Philippine Journal of Science, Manila.

POLAND.

Société Botanique de Pologne, Warszawa.
Société Polonaise des Naturalistes "Kopernik," Lwow.

RUSSIA.

Academie of Sciences, Leningrad.
Comité Géologique de Russie, Leningrade.

SPAIN.

Instituto Nacional de Segunda Ensenanza de Valencia.
Real Academia de Ciencias y Artes, Barcelona.

SWEDEN.

Entomologiska Föreningen i Stockholm.
Geologiska Föreningen, Stockholm.
Stockholm's Högskolas Bibliotek, Stockholm.
Regia Societas Scientiarum Upsaliensis, Upsala.

SWITZERLAND.

Naturforschende Gesellschaft, Basel.
Société de Physique et d'Histoire Naturelle de Genève.
Société Neuchâteloise des Sciences Naturelles, Neuchâtel.
Société Vaudoise des Sciences Naturelles, Lausanne.
Zentralbibliothek, Zürich.

UNION OF SOUTH AFRICA.

Albany Museum, Grahamstown.
Geological Society of South Africa, Johannesburg.
Royal Society of South Africa, Cape Town.
South African Museum, Cape Town.
South African Association for the Advancement of Science, Johannesburg.

UNITED STATES.

Academy of Natural Sciences of Philadelphia.
Academy of Science of St. Louis.
American Academy of Arts and Sciences, Boston.
American Chemical Society, Columbus, O.
American Geographical Society, New York.
American Microscopical Society, Manhattan, Kans.
American Museum of Natural History, New York.
American Philosophical Society, Philadelphia.
Arnold Arboretum, Jamaica Plain, Mass.
Biological Survey of the Mount Desert Region, Bar Harbour, Me.
Boston Society of Natural History, Boston, Mass.
Brooklyn Institute of Arts and Sciences.
California Academy of Sciences, San Francisco.
Californian State Mining Bureau, San Francisco.
California, University of, Berkeley, Cal.
Chicago Academy of Sciences.
Citrus Experiment Station, Riverside, Cal.
Connecticut State Library, Hartford, Conn.
Cornell University, Ithaca, N.Y.
Denison Scientific Association, Granville, O.
Field Museum of Natural History, Chicago, Ill.
Franklin Institute of the State of Pennsylvania, Philad.
Harvard Museum of Comparative Zoology, Cambridge, Mass.
Illinois State Natural History Survey, Urbana, Ill.
Illinois University Library, Urbana, Ill.
Indiana Academy of Science, Indianapolis.
Johns Hopkins University, Baltimore, Md.
Kansas University, Lawrence, Kans.
Marine Biological Laboratory, Wood's Hole, Mass.
Maryland Geological Survey, Baltimore, Md.
Michigan University, Chicago.
Missouri Botanical Garden Library, St. Louis, Mo.
National Academy of Science, Washington, D.C.
National Geographic Society, Washnigton, D.C.
New York Academy of Sciences, New York.
New York Public Library.
New York State Library, Albany, N.Y.
North Carolina Geological and Economic Survey, Chapel Hill.
Ohio State University Library, Columbus, O.
San Diego Society of Natural History, San Diego, Cal.
Smithsonian Institution and Bureau of Ethnology, Washington.
United States Department of Agriculture, Washington, D.C.
United States Geological Survey, Washington, D.C.
United States National Museum, Washington, D.C.
Wagner Free Institute of Science, Philadelphia, Pa.
Washington University, St. Louis, Mo.
Yale University Library, New Haven, Conn.

URUGUAY.

Museo de Historia Natural de Montevideo.

LIST OF FELLOWS, MEMBERS, ETC.

AS EXISTING ON SEPTEMBER 30, 1931.

Those marked with an asterisk (*) have contributed papers published in the Society's Transactions. Those marked with a dagger (†) are Life Members.
Any change in address or any other changes should be notified to the Secretary.
***Note.*—The publications of the Society will not be sent to those whose subscriptions are in arrear.**

Date of Election.

Honorary Fellows.

1910. *Bragg, Sir W. H., K.B.E., O.M., M.A., D.Sc., F.R.S., Director of the Royal Institution, Albemarle Street, London (Fellow 1886).
1926. *Chapman, F., A.L.S., National Museum, Melbourne.
1897. *David, Sir T. W. Edgeworth, K.B.E., C.M.G., D.S.O., B.A., D.Sc., F.R.S. F.G.S., Emeritus Professor of Geology, University of Sydney, Coringah, Sherbroke Road, Hornsby, N.S.W.
1898. *Meyrick, E. T., B.A., F.R.S., F.Z.S., Thornhanger, Marlborough, Wilts, England.
1894. *Wilson, J. T., M.D., Ch.M., F.R.S., Professor of Anatomy, Cambridge University, England.

Fellows.

1926. Abel, L. M. Chapman Camp, British Columbia.
1925. Adey, W. J., 32 High Street, Burnside, S.A.
1927. *Alderman, A. R., M.Sc., F.G.S., West Terrace, Kensington Gardens, S.A.
1931. Andrew, Rev. J. R., Woodside.
1929. Angel Frank M., Box 1327G, G.P.O., Adelaide.
1895. †*Ashby, Edwin, F.L.S., M.B.O.U., Blackwood, S.A.—**Council**, 1900-19; **Vice-President**, 1919-21.
1917. Bailey, J. F., Director Botanic Gardens, S.A.—**Council**, 1928-.
1902. *Baker, W. H., King's Park, S.A.
1926. Beck, B. B., 127 Fullarton Road, Myrtle Bank, S.A.
1928. Best, R. J., M.Sc., A.A.C.I., Waite Agricultural Research Institute, Glen Osmond.
1928. *Best, Mrs. E. W., M.Sc., Claremont, Glen Osmond.
1931. Birch, H. McI., M.R.C.S., M.R.C.P., Mental Hospital, Parkside.
1930. Birks, W. R., B.Sc., Principal, Roseworthy Agricultural College.
1907. *Black, J. M., 82 Brougham Place, North Adelaide—**Sir Joseph Verco Medal**, 1930; **Council**, 1927-1931. **Vice-President**, 1931-.
1924. Browne, J. W., B.Ch., 169 North Terrace, Adelaide.
1916. *Bull, Lionel B., D.V.Sc., Laboratory, Adelaide Hospital
1923. Burdon, Roy S., B.Sc., University of Adelaide.
1921. Burton, R. J., Belair.
1922. *Campbell, T. D., D.D.Sc., Dental Dept., Adelaide Hospital, Frome Road, Adelaide—**Council**, 1928-.
1907. *Chapman, R. W., C.M.G., M.A., B.C.E., F.R.A.S., Professor of Engineering and Mechanics, University, Adelaide—**Council**, 1914-22.
1931. *Chewings, Chas., Ph.D., F.G.S., "Alverstroke," Glen Osmond.
1929. Christie, W., M.B., B.S., Education Department, Flinders Street, Adelaide.
1895. *Cleland, John B., M.D., Professor of Pathology, University, Adelaide—**Council**, 1921-26; **President**, 1927-28; **Vice-President**, 1926-27.
1930. Collins, F. V., B.V.Sc., Green Road, Woodville.
1930. Colquhoun, T. T., M.Sc., University, Adelaide.
1907. *Cooke, W. T., D.Sc., Lecturer, University of Adelaide.
1929. *Cotton, Bernard C., S.A. Museum, Adelaide.
1924. de Crespigny, C. T. C., D.S.O., M.D., 219 North Terrace, Adelaide.
1916. Darling, H. G., Franklin Street, Adelaide.
1929. Davidson, James, D.Sc., Waite Agricultural Research Institute, Glen Osmond.
1928. Davies, J. G., B.Sc., Ph. D., Waite Agricultural Research Institute, Glen Osmond.
1927. *Davies, Prof. E. Harold, Mus.Doc., The University, Adelaide.
1927. Dawson, Bernard, M.D., F.R.C.S., Otago University, Dunedin, New Zealand.
1930. Dix, E. V., Glynde Road, Firle.
1915. *Dodd, Alan P., Prickly Pear Laboratory, Sherwood, Brisbane.
1921. Dutton, G. H., B.Sc., Agricultural High School. Murray Bridge.
1911. Dutton, H. H., M.A., Anlaby, Kapunda.
1931. Dwyer, J. M., M.B., B.S., Adelaide Hospital.
1902. *Edquist, A. G., 19 Farrell Street, Glenelg.

Date of Election.

1918. *Elston, A. H., F.E.S.. "Llandyssil," Aldgate.
1925. England, H. N., B.Sc., Commonwealth Research Station, Griffith, N.S.W.
1917. *Fenner, Chas. A. E., D.Sc., 42 Alexander Avenue, Rose Park—**Rep.-Governor**, 1929-; **Council**, 1925-28; **President**, 1930-31; **Vice-President**, 1928-30; **Secretary**, 1924-25
1927. *Finlayson, H. H., The University of Adelaide.
1929. Freney, M. Raphael, 14 Holden Street, Kensington Park.
1929. Freney, M. Richard, 14 Holden Street, Kensington Park.
1931. Frewin, O. W., M.B., B.S., Hindmarsh.
1923. *Fry, H. K., D.S.O., M.B., B.S., B.Sc., Glen Osmond Road, Parkside.
1930. Garrett, S. D., B.A., Waite Agricultural Research Institute, Glen Osmond.
1919. †Glastonbury, O. A., Adelaide Cement Co., Brookman Buildings, Grenfell Street.
1923. Glover, C. R. J., Stanley Street, North Adelaide.
1927. Godfrey, F. K., Robert Street, Payneham, S.A.
1904. Gordon, David, 72 Third Avenue, St. Peters.
1925. †Gosse, J. H., 31 Grenfell Street, Adelaide.
1880. *Goyder, George, A.M., B.Sc., F.G.S., 232 East Terrace, Adelaide.
1910. *Grant, Kerr, M.Sc., Professor of Physics, University, Adelaide—**Council**, 1912-15.
1931. Gray, James T., Orroroo, S.A.
1904. Griffith, H., Hove, Brighton.
1916. Hackett, W. Champion, 35 Dequetteville Terrace, Kent Town.
1927. *Hackett, Dr. C. J., 196 Prospect Road, Prospect, S.A.
1922. *Hale, H. M., The Director, S.A. Museum, Adelaide—**Council**, 1931-.
1930. Hall, F. J., Adelaide Electric Supply Coy., Ltd., Adelaide.
1922. *Ham, William, F.R.E.S., 112 Edward Street, Norwood.
1916. †Hancock, H. Lipson, A.M.I.C.E., M.I.M.M., A.Am.I.M.E., Bewdley, 66 Beresford Road, Bellevue Hill, Rose Bay, Sydney.
1924. Hawker, Captain C. A. S., M.H.R., M.A., North Bungaree, via Yacka, South Australia.
1896. Hawker, E. W., M.A., LL.B., F.C.S., East Bungaree, Clare.
1928. Hawker, M. S., Adelaide Club, North Terrace.
1923. Hill, Florence McCoy M., B.S., M.D., University of Adelaide.
1927. Holden, E. W., B.Sc., Dequetteville Terrace, Kent Town, S.A.
1929. Hosking, John W., 77 Sydenham Road, Norwood.
1930. Hosking, J. S., B.Sc., Waite Agricultural Research Institute, Glen Osmond.
1924. *Hossfeld, Paul S., M.Sc., Office of Home and Territories, Canberra.
1883. *Howchin, Professor Walter, F.G.S., "Stonycroft," Goodwood East—**Sir Joseph Verco Medal**, 1929; **Rep.-Governor**, 1901-22; **Council**, 1883-84, 1887-89, 1890-94, 1902-; **President**, 1894-96; **Vice-President**, 1884-87, 1889-90, 1896-1902; **Editor**, 1883-88, 1893-94, 1895-96, 1901-.
1928. Hurcombe, Miss J. C., 95 Unley Road, New Parkside.
1928. Ifould, Percy, Kurralta, Burnside.
1918. *Ising, Ernest H., c/o Superintendent's Office, S.A. Railways, Adelaide.
1918. *Jennison, Rev. J. C., 7 Frew Street, Fullarton Estate.
1910. *Johnson, E. A., M.D., M.R.C.S., Town Hall, Adelaide.
1921. *Johnston, Professor T. Harvey, M.A., D.Sc., University, Adelaide—**Rep.-Governor**, 1927-29; **Council**, 1926-28; **Vice-President**, 1928-31; **President**, 1931-.
1929. Johnston, W. C., Government Agricultural Inspector, Riverton.
1920. *Jones, Professor F. Wood, M.B., B.S., M.R.C.S., L.R.C.P., D.Sc., F.R.S., University, Melbourne—**Rep.-Governor**, 1922-27; **Council**, 1921-25; **President**, 1926-27; **Vice-President**, 1925-26.
1926. Julius, Edward, Conservator of Forests, Adelaide.
1918. Kimber, W. J., 28 Second Avenue, Joslin.
1915. *Laurie, D. F., Agricultural Department, Victoria Square.
1897. *Lea, A. M., F.E.S., S.A. Museum, Adelaide—**Council**, 1923-24, 1925-.
1884. Lendon, A. A., M.D., M.R.C.S., 66 Brougham Place, North Adelaide.
1922. Lendon, Guy A., M.B., B.S., M.R.C.P., North Terrace.
1925. Lewis, A., M.B., B.S., The Maudsley Hospital, Denmark Hill, London, S.E. 5.
1930. Louwyck, Rev, N. H., The Rectory, Yankalilla.
1922. *Madigan, C. T., M.A., B.Sc., F.G.S., University of Adelaide—**Council**, 1930-.
1923. Marshall, J. C.. Darrock, Payneham.
1928. Maegraith, B. J., M.B., B.S., Magdalen College, Oxford, England.
1929. Martin, F. C., B.A., Technical High School, Thebarton.
1931. Martin, Professor Sir Chas. J., Kt., C.M.G., D.Sc., University, Adelaide.
1905. *Mawson, Sir Douglas, D.Sc., B.E., F.R.S., Professor of Geology, University, Adelaide **Sir Joseph Verco Medal**, 1931; **President**, 1924-25; **Vice-President**, 1923-24, 1925-26.
1919. Mayo, Helen M., M.D., 47 Melbourne Street, North Adelaide.
1920. Mayo, Herbert, LL.B., K.C., 16 Pirie Street, Adelaide.

Date of Election.

1929. McLaughlin, Eugene, M.B., B.S., M.R.C.P., Adelaide Hospital.
1929. McLaughlin, Eugene, M.B., B.S., M.R.C.P., Adelaide Hospital.
1907. Melrose, Robert T., Mount Pleasant.
1928. Melville, L. G., B.Ec., F.I.A., Professor of Economics, University of Adelaide, Adelaide.
1924. Messent, P. S., M.B., B.S., 192 North Terrace.
1930. Miller, J. I., C.E., 18 Ralston Street, Largs Bay.
1925. †Mitchell, Professor Sir William, K.C.M.G., M.A., D.Sc., The University, Adelaide.
1930. Mitchell, Miss U. H., B.Sc., Presbyterian Girls' College, Glen Osmond.
1897. *Morgan, A. M., M.B., Ch.B., 215 Brougham Place, North Adelaide.
1924. Morison, A. J., Deputy Town Clerk, Town Hall, Adelaide.
1930. Morris, L. G., Beehive Buildings, King William Street, Adelaide.
1921. Moulden, Owen M., M.B., B.S., Unley Road, Unley.
1925. †Murray, Hon. Sir George, K.C.M.G., B.A., LL.M., Magill, S.A.
1925. North, Rev. Wm. O., Methodist Manse, Netherby.
1930. Ockenden, G. P., 11 Ailsa Street, Fullarton Estate.
1913. *Osborn, T. G. B., D.Sc., Professor of Botany, University, Sydney—**Council**, 1915-20, 1922-24; **President**, 1925-26; **Vice-President**, 1924-25, 1926-27.
1927. Paltridge, T. B., B.Sc., Koonamore, via Waukaringa, S.A
1929. Pank, Harold G., 75 Rundle Street, Adelaide.
1929. Paull, Alec. G., B.A., B.Sc., 10 Milton Avenue, Fullarton Estate.
1924. Pearce, C., Happy Valley Reservoir, O'Halloran Hill.
1927. Pennycuick, S. W., D.Sc., The University of Adelaide.
1924. Perkins, A. J., Director of Agriculture, Victoria Square.
1928. Phipps, Ivan F., Ph.D., Waite Agricultural Research Institute, Glen Osmond.
1926. *Piper, C. S., M.Sc., Waite Agricultural Research Institute, Glen Osmond.
1925. *Prescott, Professor J. A., M.Sc., A.I.C., Waite Agricultural Research Institute, Glen Osmond—**Council**, 1927-30; **Vice-President**, 1930-.
1926. Price, A. Grenfell, M.A., F.R.G.S., St. Mark's College, North Adelaide.
1907. †*Pulleine, Robert H., M.B., Ch.M., North Terrace, Adelaide—**Council**, 1914-19; **President**, 1922-24; **Vice-President**, 1912-14, 1919-22, 1924-25; **Secretary**, 1909-12, 1925-30.
1925. Richardson, Professor A. E. V., M.A., D.Sc., "Urrbrae," Glen Osmond, S.A.
1926. *Riddell, P. D., Technical College, Newcastle, N.S.W.
1911. Roach, B. S., 81 Kent Terrace, Kent Town—**Treasurer**, 1920-.
1924. Roeger, Miss M. T. P., c/o Central School, Goodwood.
1925. Rogers, L. S., B.D.Sc., 192 North Terrace.
1905. *Rogers, R. S., M.A., M.D., 52 Hutt Street, Adelaide—**Council**, 1907-14, 1919-21; **President**, 1921-22; **Vice-President**, 1914-19, 1922-24.
1931. Rudd, E. A., 10 Church Street, Highgate.
1922. *Samuel, Geoffrey, M.Sc., University of Adelaide.
1928. Scott, A. E., B.Sc., 143 Rundle Street, Kent Town.
1924. *Segnit, Ralph W., M.A., B.Sc., Assistant Government Geologist, Flinders Street, Adelaide—**Secretary**, 1930-.
1891. Selway, W. H., 14 Frederick Street, Gilberton—**Council**, 1893-1909.
1926. *Sheard, Harold, Nuriootpa.
1928. Showell, H., 27 Dutton Terrace, Medindie.
1920. Simpson, A. A., C.M.G., C.B.E., F.R.G.S., Lockwood Road, Burnside.
1924. Simpson, Fred. N., Dequetteville Terrace, Kent Town.
1925. †Smith, T. E. Barr, B.A., 25 Currie Street, Adelaide.
1927. Stapleton, P. S., Henley Beach, South Australia.
1922. Sutton, J., Fullarton Road, Netherby.
1925. Symons, Ivor G., Church Street, Highgate.
1929. *Taylor, John K., B.A., M.Sc., Waite Agricutural Research Institute, Glen Osmond.
1929. Tee, Sidney F., Adelaide Hospital.
1923. *Thomas, R. G., B.Sc., 5 Trinity Street, St. Peters, S.A.
1923. *Tindale, N. B., South Australian Museum, Adelaide.
1894. *Turner, A. Jefferis, M.D., F.E.S., Wickham Terrace, Brisbane, Queensland.
1925. Turner, Dudley C., National Chambers, King William Street, Adelaide.
1878. *Verco, Sir Joseph C., M.D., F.R.C.S., North Terrace, Adelaide—**Council**, 1924-; **President**, 1903-21; **Vice-President**, 1921-23.
1926. Wainwright, J. W., B.A., 32 Florence Street, Fullarton Estate.
1924. Walker, W. D., M.B., B.S., B.Sc., c/o National Bank, King William Street.
1929. Walters, Lance S., 157 Buxton Street, North Adelaide.
1912. *Ward, L. Keith, B.A., B.E., D.Sc., Govt. Geologist, Flinders Street, Adelaide—**Council**, 1924-27; **President**, 1928-30; **Vice-President**, 1927-28.
1920. Weidenbach, W. W., A.S.A.S.M., Geological Department, Adelaide.

Date of Election.

1930. Whitelaw, A. J., Norwood High School, Kensington.
1930. Wilkinson, Professor H. J., B.A., Ch.M., M.D., University, Adelaide.
1931. Wilson, Chas. E. C., M.B., B.S., "Woodfield," Fisher Street, Fullarton.
1920. *Wilton, Professor J. R., D.Sc., University of Adelaide.
1923. *Wood, J. G., M.Sc., University of Adelaide.
1927. Woodlands, Harold, Box 989 H, G.P.O.
1931. *Woods, Miss N. H., M.A., Mount Torrens.
1927. *Woollard, Professor H. H., M.D., University of Adelaide.

Associate.

1929. Cleland, W. Paton, 31 Wattle Street, Fullarton.

PAST AND PRESENT OFFICERS OF THE SOCIETY.

PRESIDENTS.

1877-79 Prof. Ralph Tate, F.G.S., F.L.S.
1879-81 Chief Justice [Sir] S. J. Way.
1881-82 [Sir] Charles Todd, C.M.G., F.R.A.S.
1882-83 H. T. Whittell, M.A., M.D., F.R.M.S.
1883-84 Prof. H. Lamb, M.A., F.R.S.
1884-85 H. E. Mais, M.I.C.E.
1885-88 Prof. E. H. Rennie, M.A., D.Sc., F.C.S.
1888-89 [Sir] Edward C. Stirling, C.M.G., M.A., M.D. (Cantab.), F.R.C.S., F.R.S.
1889-91 Rev. Thomas Blackburn, B.A.
1891-94 Prof. Ralph Tate, F.G.S., F.L.S.
1894-96 Prof. Walter Howchin, F.G.S.
1896-99 W. L. Cleland, M.B.
1899-03 Prof. E. H. Rennie, M.A., D.Sc., F.C.S.
1903-21 Sir Joseph C. Verco, M.D., F.R.C.S.
1921-22 R. S. Rogers, M.A., M.D.
1922-24 R. H. Pulleine, M.B., Ch.M.
1924-25 Sir Douglas Mawson, D.Sc., B.E., F.R.S.
1925-26 Prof. T. G. B. Osborn, D.Sc.
1926-27 Prof. F. Wood Jones, M.B., B.S., M.R.C.S., L.R.C.P., D.Sc., F.R.S.
1927-28 Prof. John B. Cleland, M.D.
1928-30 L. Keith Ward, B.A., B.E., D.Sc., F.G.S.A.
1930-31 C. A. E. Fenner, D.Sc.
1931- Prof. T. Harvey Johnston, M.A., D.Sc.

SECRETARIES.

1877 W. C. M. Finniss.
1877-81 Walter Rutt, C.E.
1881-92 W. L. Cleland, M.B.
1892-93 W. C. Grasby.
1893-94 W. B. Poole.
1894-95 { W. L. Cleland, M.B.
W. B. Poole.
1895-96 W. L. Cleland, M.B.
1896-09 G. G. Mayo, C.E.
1909-12 R. H. Pulleine, M.B., Ch.M.
1912-24 Walter Rutt, C.E.
1924-25 Chas. Fenner, D.Sc.
1925-30 R. H. Pulleine, M.B., Ch.M.
1930- Ralph W. Segnit, M.A., B.Sc.

TREASURERS.

1877 J. S. Lloyd.
1877-83 Thomas H. Smeaton.
1883-92 Walter Rutt, C.E.
1892-94 W. L. Cleland, M.B.
1894-09 Walter Rutt, C.E.
1909-20 W. B. Poole.
1920- B. S. Roach.

EDITORS.

1877-83 Prof. Ralph Tate, F.G.S., F.L.S.
1883-88 Prof. Walter Howchin, F.G.S.
1888-93 Prof. Ralph Tate, F.G.S., F.L.S.
1893-94 { Prof. Walter Howchin, F.G.S.
Prof. Ralph Tate, F.G.S., F.L.S.
1894-95 Prof. Ralph Tate, F.G.S., F.L.S.
1895-96 Prof. Walter Howchin, F.G.S.
1896-00 Prof. Ralph Tate, F.G.S., F.L.S.
1901- Prof. Walter Howchin, F.G.S.

REPRESENTATIVE GOVERNORS.

1877-83 [Sir] Charles Todd, C.M.G., F.R.A.S.
1883-87 H. T. Whittell, M.A., M.D., F.R.M.S.
1887-01 Prof. Ralph Tate, F.G.S., F.L.S.
1901-22 Prof. Walter Howchin, F.G.S.
1922-27 Prof. F. Wood Jones, M.B., etc.
1927-29 Prof. T. H. Johnston, M.A., D.Sc.
1929- Chas. Fenner, D.Sc.

THE SIR JOSEPH VERCO MEDAL.

Awards.

1929 Prof. Walter Howchin, F.G.S.
1930 John McC. Black.
1931 Prof. Sir Douglas Mawson, B.E., D.Sc., F.R.S.

ROYAL SOCIETY OF SOUTH AUSTRALIA
(INCORPORATED).

SUGGESTIONS FOR THE GUIDANCE OF AUTHORS IN THE PREPARATION OF MSS. TO BE SUBMITTED TO THE SOCIETY.

1. The manuscript must be clearly written (especially in the case of scientific and technical terms), and in a form ready to be placed in the hands of the printer. It is a great advantage for MSS. to be typed, double spaced. If the paper be illustrated, the illustrations, maps, etc., must be supplied in a form ready for reproduction. Where reduction is required, detail and lettering must be proportionally enlarged. It may be necessary to return MSS. to authors for typing. In returning proofs to the Editor, the original copy should be included.

2. Uniformity must be preserved throughout in the use of capital letters, italics, abbreviations, punctuation, etc.

3. All generic and specific names must be underlined (denoting italics). Other scientific nomenclature must be in roman. Generic names must begin with a capital letter, and specific and varietal names (even where a proper name is used) must begin with non-capitals, as, for example, *Lovenia forbesi* T. Woods. (An exception to this rule is made in the case of botanical names, where the usage is to retain the capital letter in proper names.)

4. Diphthongs are not allowed; each vowel must be written separately, as, for example, Archaeocyathinae.

5. In the case of original descriptions the following abbreviations should be used: n. gen., n. sp., n. var.

6. Authors and authorities, following a name in roman, must be in italics; following a name in italics, to be in roman; when the species is transferred to another genus the name of the original author to be enclosed in parentheses. (No comma shall appear between the specific name and the name of the author.)

7. The names of Australian States are to be written in full in the text, but in the footnotes and synonymy are to be abbreviated as follow:—Australia, Aust.; New South Wales, N.S.W.; Victoria, Vict.; Tasmania, Tasm.; South Australia, S. Aust.; Western Australia, W. Aust.; Queensland, Qld.; North Australia, N. Aust.; Central Australia, C. Aust.; New Guinea, N. Guin.; New Zealand, N.Z.; Federal Capital Territory, F.C.T. Aust. Western Australia, not West Australia.

8. Symbols or abbreviations used to save trouble in writing, but not intended to appear as such in the printed text, are not allowable.

9. The maximum size of illustrations (maps excepted) to be 7½ inches x 5 inches for plates, and 7¾ inches x 5 inches for text figures.

10. Papers submitted to the Society for reading must be lodged at the Society's rooms at least a week before the meeting of Council, which is held on the fourth Thursday in each month, from March to November, inclusive.

See also By-laws, Section VII.—Papers.

Note regarding Abstracts.—The author is requested to supply two brief abstracts of his paper—one for local use, and another, not exceeding 50 words, to be sent to publications which cannot grant more space.

ROYAL SOCIETY OF SOUTH AUSTRALIA

(INCORPORATED).

RULES, AS AMENDED, 1931.

NAME.

1. The Title of the Society is the "Royal Society of South Australia (Incorporated)," hereinafter called the Society.

OBJECTS.

2. The objects of the Society are the promotion and diffusion of scientific knowledge by Meetings for the reading and discussion of Papers, and by such other methods as the Council may from time to time determine.

CONSTITUTION.

3. The Society shall be constituted of persons of either sex who are enrolled as Members. They shall be classed as Fellows, Honorary Fellows, and Associates.

4. Honorary Fellows shall be persons distinguished for their attainments in science, or who have rendered signal service to the Society.

5. Men or women may be Associates; men Associates shall be under the age of 21 years.

6. Associates shall be entitled to become Fellows upon written application to the Council, and payment of the prescribed Subscription payable by Fellows.

7. Honorary Fellows and Associates shall be entitled to all the privileges of Fellows, except that they shall not debate nor vote upon questions dealing with the management of the Society's business.

ELECTION OF MEMBERS.

8. Every Candidate for Membership shall be nominated on the prescribed Form by two Fellows, one of whom shall attest from personal knowledge of the Candidate.

9. The Nomination Form shall be lodged with the Secretary, and shall be submitted to the Council and the Society at their next following Meetings, and the election shall be held at the next Ordinary Meeting.

10. No person shall be eligible for election as an Honorary Fellow unless recommended by the Council.

11. Elections shall be by ballot, one negative in every six or part of six excluding.

12. A Candidate who has been so excluded shall not be eligible to be again nominated within one year of such exclusion.

13. Every person elected shall have immediate notice thereof transmitted to him by the Secretary, on the prescribed Form, stamped with the Seal of the Society, accompanied by a copy of the Rules and By-laws, and shall be enrolled as a Member, after having paid the necessary fees.

14. Within three months of the election of a Member, the Treasurer shall send him a Notice for the Subscription due.

15. At the Meeting of the Council prior to the Annual Meeting of the Society in each year, the Treasurer shall present a list of all Fellows whose Subscriptions are two years or more in arrear.

16. The Secretary shall keep an Official Roll of the Members of the Society, and this, together with the Annual Report of the Council, shall be published in the volume of the Proceedings.

Cessation of Membership.

17. A Member may resign his Membership at any time by notification in writing to the Secretary, and shall thereupon cease to be a Member, but shall not thereby be released from any indebtedness to the Society.

18. If any Fellow or Associate whose Subscriptions shall be more than twelve months in arrear shall fail to pay the same after notification in writing by the Treasurer, the Council may cancel his Membership, and he shall thereupon be notified by the Secretary and cease to be a Member.

Restoration.

19. The Council may, upon such terms as it shall think fit, re-enrol as a Member any person who shall have ceased to be a Member.

Management.

20. The management of the affairs and funds of the Society, and the custody of its property, shall, subject to any By-laws for the time being regulating or prescribing conditions as to the same, be vested in a Council, composed of a President and such other Officers and Members as may be prescribed, who shall be elected and hold office for such periods as may be prescribed.

President.

21. The President shall, if present, preside at all Meetings of the Council or Society. In the absence of the President, his duties shall be carried out by such other Officer or Person denoted or elected in the manner prescribed.

Seal and Sealholder.

22. The Common Seal shall have the name of the Society inscribed upon it, and shall be held by the Secretary, who shall for all legal purposes be deemed to be the Sealholder.

23. The Council shall have the power to use the Seal in the execution of any powers hereby invested in it or otherwise in relation to the affairs or business of the Society. The Seal shall not be used except by the authority of the Council. The Secretary and at least two other Members of the Council shall sign every instrument to which the Seal is affixed, except the notice sent by the Hon. Secretary to a new Member.

MEETINGS OF THE SOCIETY.

24. A meeting of the Society, to be called the Annual Meeting, shall be held in the month of October in every year, upon a day and at a place to be appointed by the Council.

25. At the Annual Meeting the Council shall submit a Report and a duly audited Financial Statement, and the Meeting shall fill all vacancies among the Officers and the Members of the Council for the ensuing year, and transact any other business of which due notice has been given.

26. The Council may convene an Ordinary Meeting of the Society at any time.

27. The Council may at any time, and shall upon the requisition in writing of at least seven Fellows specifying the purpose for which the Meeting is required, convene a Special Meeting of the Society. The special business for which the Meeting has been convened, and no other, shall be transacted at such Meeting.

28. Seven Fellows shall form a quorum. If at any Meeting a quorum is not present within fifteen minutes after the hour of Meeting, the Meeting shall stand adjourned to a day and time to be appointed by those present not being earlier than seven days. At the Adjourned Meeting the Fellows then present may proceed to business, although fewer than the prescribed quorum may be present.

29. At least three days' notice of every Meeting or Adjourned Meeting, and of the principal items of business to be transacted thereat, shall be given to the Members resident in South Australia by printed notice, or in such manner as may be prescribed.

AUDITORS.

30. Two persons, not being Members of the Council, shall be elected at the Annual Meeting of the Society in each year to audit the Financial Statement for the following year.

BY-LAWS.

31. The Council may make, repeal, alter, or vary By-laws not inconsistent with these Rules for the effective carrying out of the objects and purposes of the Society; but no such By-law, repeal, alteration, or variation shall be valid unless approved by a majority of the Fellows voting at a Meeting of the Society of which due notice has been given.

ALTERATION OF RULES.

32. The Society may, by a majority of at least-two-thirds of the Fellows present at an Annual Meeting, or at a Special Meeting duly convened for the purpose, make any Rule, or repeal, alter, or vary any existing Rule.

33. In the construction of the Rules of the Society, unless the subject or context requires a different meaning:—

"By-law" shall include regulations under "The Public Library, Museum, and Art Gallery and Institute Act, 1909," or any other Act or Power enabling the Society to make Regulations.

"Prescribed" means prescribed by By-law.

Words denoting the singular number only shall be deemed to include the plural and vice versa. Words denoting the masculine gender shall be deemed to include the feminine.

34. All Rules and By-laws of the Society heretofore in force are hereby repealed.

BY-LAWS.

I.—Nomination Paper for Fellows.

The Nomination Paper referred to in Rules 8 and 9 shall state the full name, distinctions (academic or otherwise), address and occupation of the Candidate, and the class of Membership for which he is nominated. When elected, the date of this election shall be entered upon the Nomination Paper, and signed by the Chairman of the Meeting.

II.—Council.

1. The Council shall consist of twelve (12) Fellows, *viz.*, six Officers and six other Fellows. The Officers shall be a President, two Vice-Presidents, a Treasurer, an Editor, and a Secretary. Any four Fellows of the Council shall form a quorum.

2. At each Annual Meeting all Officers shall retire, and also two other Members of the Council, but all retiring Members shall be eligible for re-election. The Non-official Members to retire shall be those who have been longest in the Council since their last election, or in case of equal tenure, the retirement shall be decided by lot.

3. The vacancies on the Council shall then be filled by election, which shall be by ballot, if so required by any Fellow.

4. The Secretary shall keep a record of attendance of Members at all Meetings of the Council, and present it at the Annual Meeting held in the month of October in each year.

5. If any Member of the Council absents himself for the period of three months from all the Meetings of the Council held during such period, without the permission of the Council, granted by resolution of the Council before the expiration of such period, his position as a Member of the Council shall become vacant.

6. Every casual vacancy in the Council shall be filled at the next Meeting of the Society (by ballot, if demanded by any Fellow).

7. Any matter within the powers of management of the Council may be submitted to the Society in the following manner:—

(a) If referred to the Society by resolution of the Council; or

(b) If Notice of Motion in writing referring to such matter be given to the Secretary by two Fellows.

8. In either case, at the next Meeting of the Society the Fellows who have given Notice, or failing them (or if the matter be referred to the Council), any Fellow may move. The resolution (if any) of the Meeting shall be binding on the Council, *provided, however,* that such resolution shall not prejudice or affect anything authorised and done by or on behalf of the Council relating to such matter, if the same be done prior to the receipt of Notice of Motion by the Secretary.

III.—Subscriptions.

1. The Annual Subscription of a Fellow shall be one guinea.

2. A Fellow may at any time compound for future Annual Subscriptions by the payment of fifteen guineas, and shall be called a Life Fellow.

3. Associates shall subscribe half-a-guinea per annum.

4. All Subscriptions shall be payable in advance immediately after the Annual Meeting, or on receipt of Notice of Membership, as the case may be, to the Treasurer, who shall give a receipt on a printed form for the sum received.

5. The financial year shall extend from October 1 to September 30. Membership for the whole or any part of any financial year shall entail the payment of the Subscription for that year, and shall entitle the Member to the receipt of any publication issued free to Members during that year.

IV.—Endowment Fund.

1. The Endowment Fund, and such money as may be added to it from time to time, shall remain intact unless decided otherwise by a majority consisting of at least five-sixths of Fellows whose Subscriptions are fully paid, and who have met at a Special Meeting duly convened for that purpose.

2. Securities, bonds, stocks, etc., belonging to the Society shall be deposited in a Bank, or other place selected by the Society, and shall be made available for inspection only on the written authority of the President, or, in his absence, a Vice-President, who shall give a written Order to the Manager of the Bank, or other responsible Officer who has the securities, etc., in custody.

V.—Library Committee.

1. The Library Committee shall consist of the President, two Vice-Presidents, Secretary, Editor, and one other Member elected by the Council, of whom three shall constitute a quorum. The Librarian to act as the Secretary.

2. The Committee shall meet at such times as may be determined, and after due Notice shall have been given.

VI.—Meetings of the Society.

1. Meetings shall be held on the second Thursday in each month, from April to November, at 8 p.m., in the Society's Rooms, unless the Council shall otherwise decide. Each Meeting shall be convened by Circular posted not less than three days prior to the date of the Meeting to the last known address of each Member resident in the State. The Circular shall state the Subjects to be brought before the Society, the Names of Candidates for Membership, and any Notices of Motion.

2. In the absence of the President, one of the Vice-Presidents shall take the chair; and in the event of their absence, the Members present shall elect one of their number as Chairman.

3. The business shall be transacted in the following Order, unless it be specially decided otherwise by the Meeting:—

(a) Reading and confirmation of the Minutes of last Meeting.
(b) Correspondence.
(c) Election of Members.
(d) Nomination of Candidates for Membership.
(e) Consideration of Motions of which Notice has been given.
(f) Reading of Notices of Motions for subsequent Meetings.
(g) Consideration of any special matters which Members may desire to bring forward, subject to the approval of the Chairman obtained before the commencement of the Meeting.
(h) Any other business brought forward by the Council.
(i) Papers or Discussions notified on the Circular.
(k) Exhibits.

VII.—PAPERS.

1. No Paper which has not been previously approved by the Council shall be brought before the Society.

2. Every Paper intended for presentation before the Society shall be deposited with the Secretary, or at the Rooms of the Society, not later than the third Thursday of any month, from March to November.

3. The Council shall, at its next Meeting, consider whether such Paper will be read.

4. At the Council Meeting subsequent to the reading of the Paper, the question of publication shall be considered.

5. If the Council decides to publish the Paper, in whole or in part, it and all copyrights thereof shall become the property of the Society, such copyrights to include all plates, maps, diagrams, and photographs reproduced in illustrating the Paper. All manuscripts and original illustrations must be returned to the Editor with the corrected proofs.

6. All matter used in illustration of Papers (whether photographs, prints, negatives, or drawings) remains the property of the Authors. Blocks used for illustrations may be obtained on application to the Librarian. Any subsequent publication of such material shall be by permission of the Council in writing, and the source of such copyright material shall be duly acknowledged. The illustrations shall be returned to the Secretary by the Printer on publication of the volume and shall be kept in safe custody for one year, unless previously claimed by the Author. After the expiration of one year they may be disposed of as the Council shall direct.

7. If the Council decides not to publish a Paper, either in whole or in part, it shall be returned to the Author, if he so desires.

8. All Papers and other contributions to be published by the Society shall be subjected to editing by the Editor.

9. The Author of any Paper published by the Society shall be entitled to receive free of cost 25 copies, and to obtain additional copies (not exceeding 75, unless the Council shall determine otherwise) upon paying the extra cost thereof. Every such copy shall include a statement that it is taken from the publications of the Society.

10. All contributions and excerpts intended for publication by the Society shall be typed (double spaced) or clearly written on one side of the paper, and shall be in accordance with the "Suggestions for the Guidance of Authors" published in the last Volume of the Proceedings of the Society.

11. A proof shall be submitted (if possible) to the Author, who shall be allowed to make any slight amendments without cost, but if the corrections are deemed by the Council to be excessive, they must be paid for by the Author.

12. In order to secure correct reports in the Press and Science Abstracts, each Paper or other contribution laid before the Society must be accompanied by three short synopsis, one of which must not exceed 50 words.

VIII.—SECTIONS.

1. With the consent of the Council, Sections may be formed in connection with the Society for the special study of particular branches of Natural or Applied Science.

2. Such Sections shall consist of:—

(a) Members of the Society who join the Section and pay an Annual Subscription to the Section.

(b) Other persons who have been duly elected to the Section and who pay its Annual Subscription.

3. A Member of the Society who joins any Section shall not be required to pay an Entrance-fee, and the Annual Subscription paid by him shall not exceed one-half of that paid by Non-members of the Society.

4. Each Section shall elect its own Committee of Management.

5. The President and Vice-Presidents of the Society, for the time being, shall be Ex-officio Members of the Committee of Management of all Sections.

6. The Rules and Regulations for the management of Sections shall not have effect until they have been formally approved by the Council of the Society.

7. Subscribers to the Sections shall have access to the Library of the Society, subject to such conditions as may be imposed by the Council.

8. The Committee of Management of each Section shall, on or before September 15 of each year, furnish to the Council of the Society an Annual Report of the Procedings of the Section and its Balance-sheet.

9. Sections, and approved Societies, shall be allowed the use of the Society's Rooms at such times as may be approved by the Council, on payment of rental at the rate of thirty shillings per annum.

10. Grants of money out of the general funds of the Society may be made by the Council to any Section.

IX.—Regulations for the Election of a Member of the Board of Governors of the Public Library, Museum, and Art Gallery of South Australia, pursuant to "The Public Library, Museum, and Art Gallery and Institute Act, 1909."

1. At a Meeting in October the Council shall elect one Member of the Board; such election shall be by ballot, if so required by a Member.

2. No person shall be elected unless he is at the time of his election a Member of the Society, nor shall he continue to hold office as such Member of the Board if he ceased to be a Member of the Society.

3. The elected Member shall hold office until the election of his successor, and shall then retire, but may be re-elected.

4. Every casual vacancy shall be filled at the next Meeting of the Society (by ballot if demanded by any Fellow).

5. The result of each election shall be certified to His Excellency the Governor under the hand of the President.

6. The elected Member shall be deemed to be the representative of the Society upon the said Board, and shall (subject to his duties to the Board) report to the Council all matters concerning the Society which may be dealt with by the Board, and shall make such representations on behalf of the Society as the Society or the Council may from time to time direct.

GENERAL INDEX.

[Generic and specific names in italics indicate that the forms described are new to science.]

PLATES 1 to VIII.

Fig. 1.

Fig. 2.

Photos by H. H. Finlayson.

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Photo by H. H. Finlayson.

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Photo by H. H. Finlayson.

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Fig. 1

Fig. 2

Fig. 3

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Photo by W Howchin

Fig. 1 Ancient Consolidated River Remains exposed by erosion in the Walloway Creek.

Photo. by R. F. Stevens

Fig 2. Ancient Consolidated River Remains in the neighbourhood of Caltowie. A higher line of exposure can be seen in the background.

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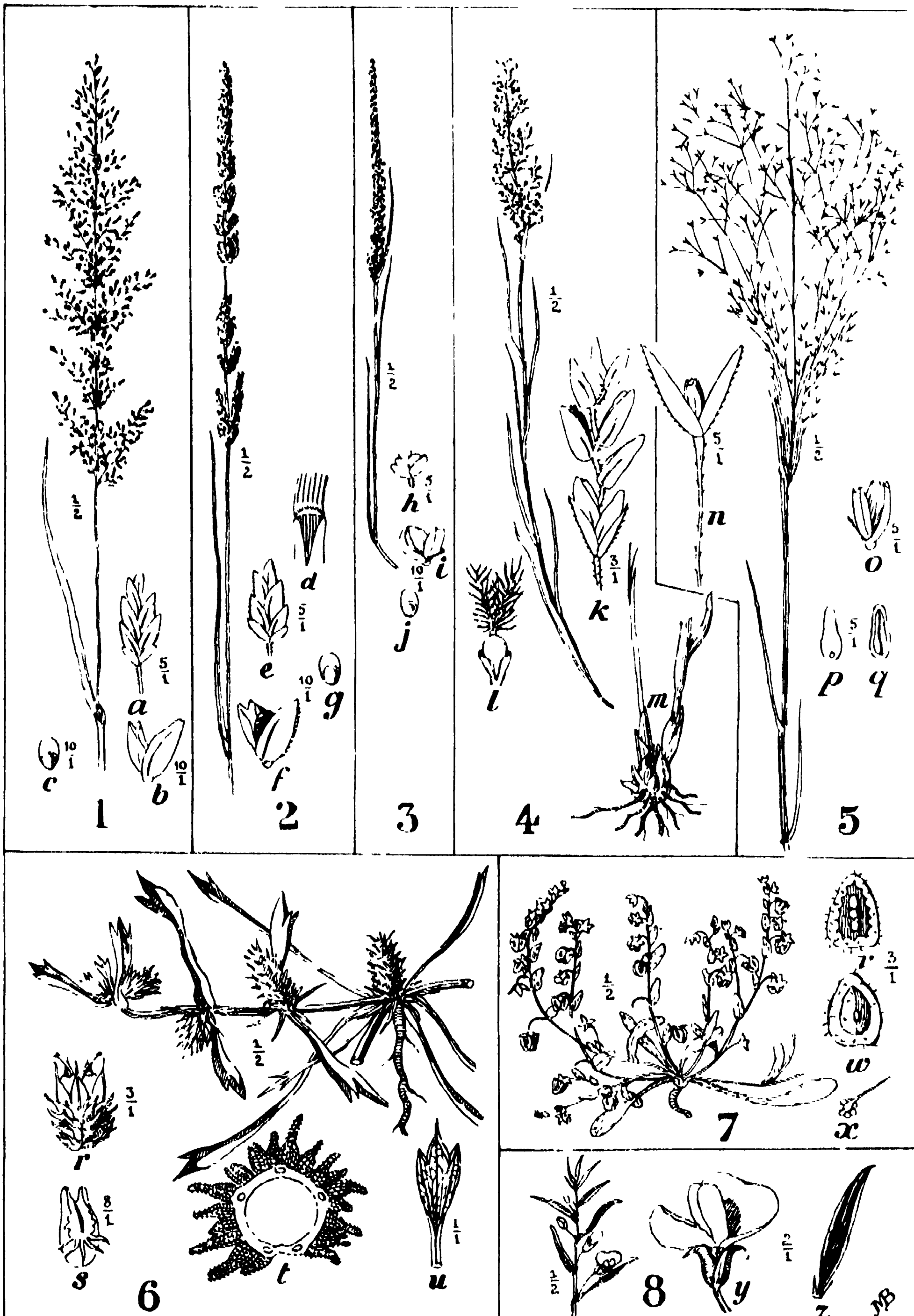

1, *Eragrostis japonica.* 2, *E. confertiflora* 3, *E. Kennedyae* 4, *E infecunda.* 5, *Agrostis limitanea.* 6, *Eryngium supinum.* 7, *Embadium stagnense.* 8, *Pultenaea quadricolor.*

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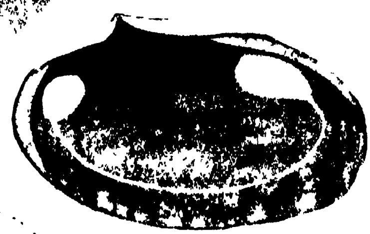

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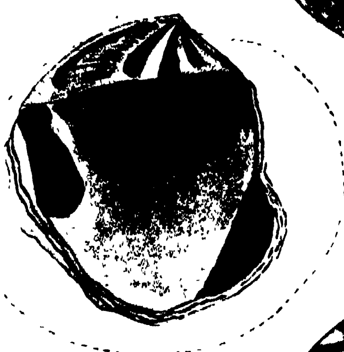

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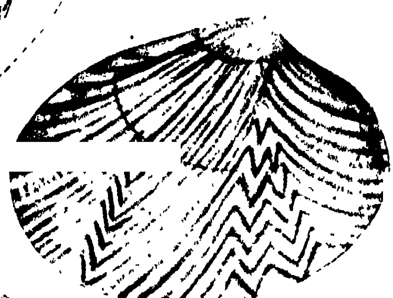

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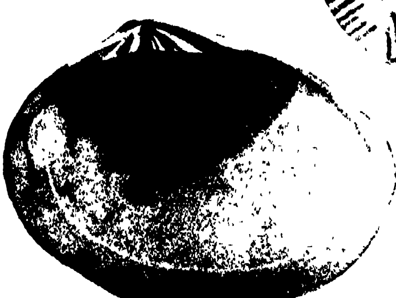

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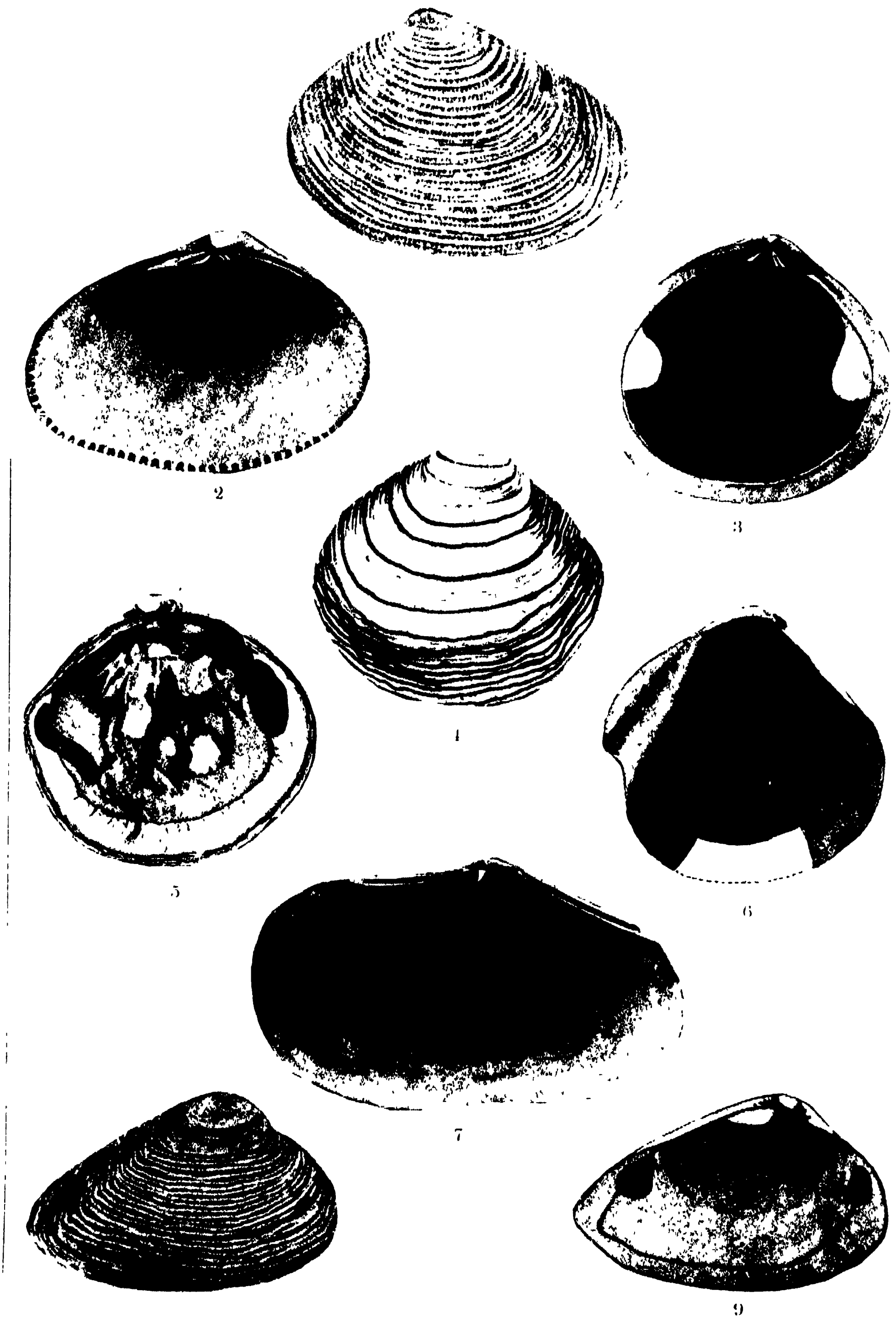

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TRANSACTIONS AND PROCEEDINGS

OF THE

ROYAL SOCIETY OF SOUTH AUSTRALIA

(INCORPORATED)

VOL. LVI.

[WITH PORTRAIT, NINE PLATES, ONE MAP, AND FORTY-THREE FIGURES IN THE TEXT]

EDITED BY PROFESSOR WALTER HOWCHIN, F.G.S.

[*Each Author is responsible for the soundness of the opinions given, and for the accuracy of the statements made in his paper*]

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ROYAL SOCIETY OF SOUTH AUSTRALIA

(INCORPORATED).

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THE LATE ARTHUR M. LEA.

By courtesy of the Board of Governors of the Public Library, Museum, and Art Gallery.

Transactions

of

The Royal Society of South Australia (Incorporated)

VOL. LVI.

OBITUARY NOTICE.

ARTHUR MILLS LEA.

WITH PORTRAIT AS FRONTISPIECE.

Arthur Mills Lea died suddenly and wholly unexpectedly in Adelaide on February 29, 1932. This Society has suffered the loss, not only of one of its oldest Associates, but one of its most notable Fellows.

Mr. Lea was born in Sydney 63 years ago. In 1891 he joined the Department of Agriculture, New South Wales, as Assistant Entomologist to the late A. Sidney Oliff, then Government Entomologist of that State. In 1895 he was appointed Government Entomologist of Western Australia, and four years later (1899) accepted a similar position in Tasmania, where he carried out a great deal of useful research on the insect pests of fruit, etc. In 1911 he became Entomologist to the South Australian Museum, and when he died had almost completed 21 years of service in that office.

He was a Fellow of this Society for 35 years, having been elected in 1897. He was interested in all its activities, and our Minutes show that for two decades he exhibited specimens at most of the meetings. He was a member of our Council for the past nine years and, more recently, assisted in the editing of the "Transactions." His whole-hearted enthusiasm for entomological research was manifested in many ways; as an instance, one may mention that he personally typed several written manuscripts, submitted by other authors, in order that they might be the more readily acceptable to the Council.

When Mr. Lea came to the South Australian Museum, the entomological collection there was relatively small; at the present time it includes one million specimens, and will long stand as a monument for his two decades of zealous service and untiring effort. He enhanced the value of this collection exceedingly by describing an amazing number of new species. His ambition at one time was to erect 5,000 species, but when he died he had described nearly 6,000—an unrivalled feat.

While much of his work was printed in Sweden, Germany, Belgium, etc., he submitted no fewer than 43 papers for publication in the "Transactions" of this Society. These occupy the equivalent of 2,378 pages, and include 904 illustrations and the description of 2,329 new species.

From time to time Mr. Lea made many trips to other States and to parts of South Australia where little research had been carried out. One of the most important of his expeditions was undertaken in 1924, on behalf of the Levuana Committee, when he spent a year on a mission to Queensland, Thursday Island, Java, Malaya, Borneo, etc., in order to study methods of controlling the Coconut Moth *(Levuana iridescens)* in Fiji. He also played a prominent part in the investigations carried out on wheat pests, in 1918-1919, when the vast quantities of wheat stored in Australia as a result of the war were being destroyed by weevils. Numerous investigators in other countries were assisted materially by him in their fight against pests introduced from Australia, and in all cases his work was considered of great value.

Another factor governing the rapid increase in the entomological collections at the Museum was Mr. Lea's happy knack of transmitting his enthusiasm to private workers and others, and material secured by such persons is constantly being received from all over Australia.

In further reference to his work at the Museum, one has often been astounded at the amount of correspondence which passed through his hands, the number of queries which he attended to each day, the quantity of specimens identified for other institutions, for farmers, orchardists, and hosts of others. His painstaking efforts on behalf of every enquirer—the least of which was given his full attention and consideration—will be missed greatly all over the world. Knowing of his multitudinous activities, one marvelled how he found time for the vast amount of research work which he produced.

Apart from all this, "Arthur Mills Lea" stands for more than the name of our most ardent entomologist, of a prolific writer and of a participant in the activities of six learned Societies and many other bodies. It will ever call to mind a man who formed a human association with all those he came into contact with, and therefore his passing will remain a personal grief to all who were thus privileged.

Fellows of this Society, and all Mr. Lea's other colleagues in Australia, not only esteemed him for his sterling qualities, but regarded him with sincere affection.

HERBERT M. HALE.

April 14, 1932.

THE SOILS OF THE SOUTHERN PORTION OF THE HUNDRED OF KUITPO, SOUTH AUSTRALIA.

By J. K. TAYLOR, B.A., M.Sc.,[1] and J. O'DONNELL, B.Sc. (Agr.), Dip. For.[2]

[Read November 12, 1931.]

CONTENTS.

I. DESCRIPTION OF THE AREA SURVEYED.

A soil survey of the southern portion of the Hundred of Kuitpo was undertaken by the Division of Soil Research of the Council for Scientific and Industrial Research in the early part of 1931, with a view to studying in some detail the classification of the soils, their relation to major plant associations and their probable agricultural value. The present paper summarises the field observations and some analytical data on the nature and distribution of the soils, and it is believed will form a satisfactory guide to the soils of the remainder of the Hundred. Previous investigations by Teale (1) and Jacobs (2) supply some information on the soils, physiography and vegetation of this area, and further records of the vegetation are found in papers by Adamson and Osborn (3) and Wood (4).

The area on which the present work was carried out occupies approximately the southern half of the Hundred of Kuitpo, a rough line from Wickham's Hill to Reynell's Hill constituting the northern boundary. The tract so enclosed embraces 30,000 acres, including 13,480 acres of Crown land reserved for forestry purposes. The main physiographic features are the broad Meadows Creek Valley with numerous tributaries, and the lesser Blackfellows Creek Valley, the sharply-defined quartzite ridges forming the eastern and western boundaries of the Hundred and the intensely dissected, steep-sided, flat-topped remnants of the ancient peneplain which originally covered the whole area between the bounding ranges. The southern part of the surveyed area has this latter feature strongly marked, emphasised by steeper slopes, shallow soils and outcropping rock. North of the Willunga-Bull's Creek road, the main valleys are broader, and the slopes, especially on the western side of Meadows Creek, less steep. A considerable portion of the northern section is occupied by the broad alluvial flat of the Meadows Valley.

(1) Division of Soil Research. Council for Scientific and Industrial Research.
(2) Department of Forestry, Western Australia.

The area is not yet developed to its fullest extent, many large tracts supporting natural vegetation from which all millable timber has been removed, while the cleared lands have been only partially improved. A portion has been reserved as a State forest and is in process of conversion to conifer plantations. At the present time 4,000 acres have been planted with various species, principally *Pinus radiata*. Of the privately owned land some has been intensively developed for grazing, some used for small scale market gardening and dairying, while considerable areas have been planted to various fruit trees, mainly apples, which were profitable up to recent years. The collection of wattle bark *(Acacia pycnantha)* and firewood contracts provide useful sidelines for some of the community. Factors militating against the successful development of the country are the large numbers of rabbits, and the fire danger, which appears to be fairly high.

II. CLIMATOLOGICAL DATA.

Official climatic data for Kuitpo are not available, although rainfall observations have been made at Meadows and at Kuitpo Forest headquarters. The figures indicate a distinct seasonal fall, approximately 25 inches of the annual 35 inches falling in the period April to September, while the December-February rainfall averages only one inch per month. No temperature records have been kept; the hottest periods coincide with those of least precipitation, and frosts occur frequently during the winter and early spring, being most severe in the Meadows Valley. Rainfall data for Meadows and Kuitpo Forest are given in Table 1.

TABLE 1.

Station.	No. of Yrs.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
Meadows	28	1.03	0.79	1.91	3.16	3.68	5.48	4.47	4.48	3.98	2.97	1.83	1.24	35.02
Kuitpo Forest	18	0.89	1.29	1.15	2.03	4.69	5.00	4.29	4.04	4.15	2.65	1.57	1.43	33.18

III. THE SOILS.

(1) CLASSIFICATION AND DISTRIBUTION OF SOIL TYPES.

The recognition of the various soil types in the field was based on the nature of the whole profile. Certain types are associated to some extent with geological formations—in one case definitely allied—but these associations were only considered as indicative of the general soil boundaries. An attempt has been made to name the soil types on the same system that has been used by the Soil Survey Division of the United States Bureau of Soils, *i.e.*, by a "series" name and a "class" name. The former is a general title denoting the constitution of the profile, the name usually being taken from a nearby town or river, and the latter indicates the texture of the surface soil. Wherever this profile is encountered the same series name must be applied, although the class name may be different.

The seven soil types, belonging to five soil series, recognised in the survey were as follows:—

Meadows clay loam.—An alluvial dark grey to black soil overlying heavy clay. Occurs only in valley bottoms.

Meadows fine sand.—An alluvial grey to white clayey fine sand overlying yellow heavy clay. Occurs only in valleys.

Meadows sand.—A grey to white sand or coarse sand overlying yellow heavy clay.

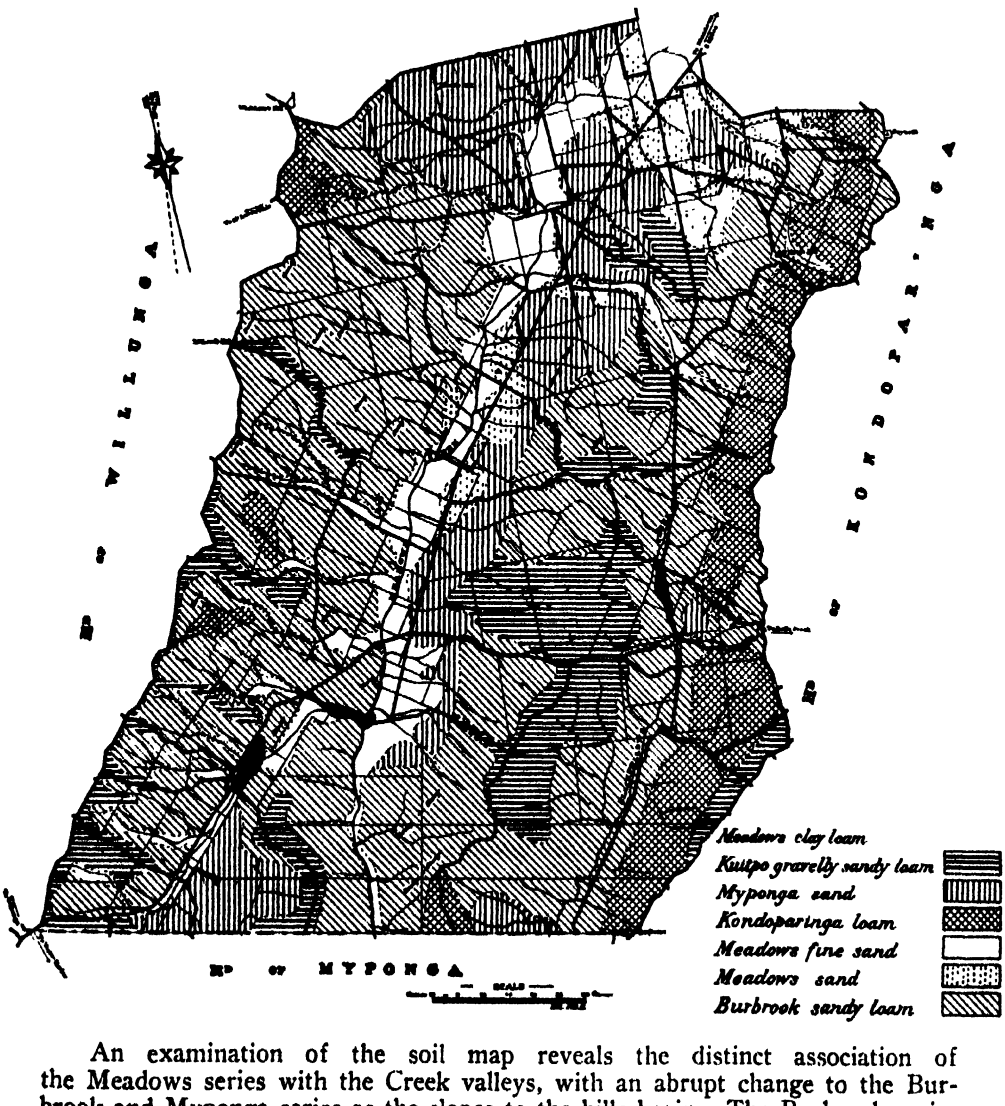
Myponga sand.—A deep podsolised grey to white sand overlying yellow sand over sandstone. A distinct typical coffee-brown layer is often present between 30-60 inches.

Kuitpo gravelly sandy loam (lateritic).—Grey to yellow sandy loam, with varying content of ironstone gravel over yellow friable clay with ironstone gravel.

Burbrook sandy loam.—Grey sand or sandy loam over buff loam or friable clay over rock (schist and quartzite). Frequently stony and shallow soil.

Kondoparinga loam.—Brown loam, sometimes moderately high in silt over phyllites.

SOIL SURVEY OF
PART OF
H^D OF KUITPO



An examination of the soil map reveals the distinct association of the Meadows series with the Creek valleys, with an abrupt change to the Burbrook and Myponga series as the slopes to the hills begin. The Burbrook series is the universally occurring soil over a wide range of conditions, and in all phases from extremely stony to moderately deep. Along the eastern boundaries on the

slope from Bull's Creek and Mount Magnificent Ranges occurs the Kondoparinga loam as an almost continuous band. Its occurrence is determined by the presence of micaceous schists, from which it is directly derived. The Kuitpo series occurs only on the flat-topped ridges and on a plateau formation crossed by the Bull's Creek-Willunga road. Approximately the same elevation was noted in a number of aneroid readings on different areas of this soil type. The ironstone gravel is the distinctive feature, and on occasions formed a stony layer not penetrable by the auger. The Myponga sands are found mainly in the north of the area following down the east side of Meadows Creek, with two areas crossing the southern boundary into the Hundred of Myponga.

(2) Description of Soil Types.

(a) (i.) Meadows clay loam—96 acres. The occurrence of this type is limited to numerous small areas on the actual creek lines in the valley bottoms, chiefly in the Meadows Valley. Many of the areas are too restricted for reproduction on the soil map.

The diagram is typical of the heavier soil of the Meadows Creek, lighter forms being found in secondary valleys. The black surface soil may be 12 inches deep. The subsoil passes to a grey or mottled yellow and grey stiff clay, and ultimately to a yellow heavy clay; this horizon appears on creek banks to a depth of 72 inches and is probably of greater depth. The surface colour is due to organic matter, which is approximately 4% to 5% in the samples analysed. Some analyses are given in Table 2 below. In sample 2018-2019 the clay content rises sharply from 28% to 48% and continues at a high figure; the lighter form of the type (sample 1929-31) contains less clay but proportionately more silt.

Loam to clay loam	.. 2"	Grey black to black
Clay	. 8"	Grey
Heavy clay		Grey and yellow mottled
		to
Heavy clay	72" max.	Yellow

Table 2.

Mechanical Analyses, Reaction and Nitrogen Content of Soils of the Meadows Series.

Soil Type.	Meadows clay loam.		Meadows clay loam.			Meadows fine sand.		Meadows fine sand.	
Sample No. ...	2018	2019	1929	1930	1931	1917	1918	2015	2016
Depth in inches	0–2	2–8	0–4	4–20	20–36	0–12	12–30	0–1	1–10
	%	%	%	%	%	%	%	%	%
Coarse sand	10·2	3·4	1·6	2·7	0·3	18·0	5·8	10·3	12·4
Fine sand	33·1	20·3	40·6	40·8	36·3	51·8	19·1	52·7	53·6
Silt	18·8	17·2	33·0	30·1	30·4	24·7	10·0	25·7	25·5
Clay	27·9	47·7	15·1	23·4	31·5	4·1	58·0	5·7	4·9
Loss on acid treatment	0·9	0·9	0·6	0·4	0·3	0·0	0·3	0·3	0·1
Moisture	3·9	5·1	2·4	1·6	2·1	0·4	7·4	2·1	1·4
Loss on ignition	9·7	8·7	9·5	4·3	5·5	1·4	7·3	4·5	1·6
Nitrogen	%0·24	0·17	0·30	0·06	0·02	0·03	—	0·15	0·03
pH.	5·5	5·9	5·9	6·0	6·7	5·7	5·6	4·9	4·9
Moisture equivalent	%28·7	34·5	30·7	23·3	25·9	—	35·0	18·3	14·8
Sticky point	%45·5	48·7	—	28·7	31·4	—	—	31·9	21·4

(ii.) Meadows fine sand—3,930 acres, and *Meadows sand*—1,045 acres. Meadows fine sand occurs along major creek lines, broadening at intervals into wide alluvial flats, which, in the case of Meadows Creek, vary from 10 to 60 chains in width. Surface flooding and temporary waterlogging apparently occur regularly, and the heavy clay subsoil prevents free percolation of water.

Fine sand	.. . 2"	Dark grey to grey
Fine sand .. Slight gravel	12"	White
Heavy clay, varying ironstone gravel		Yellow
	72" max.	

The dark-grey to grey fine sand passes at a depth of 2 inches to a white fine sand containing frequently a small amount of fine gravel. This changes sharply at 12 inches to a yellow heavy clay, which continues as a deep layer containing some ironstone gravel washed from the higher ridges. During dry periods the surface soil becomes floury and the subsoil very hard. In Table 2 are given three analyses of the surface soils and one subsoil to show the relative textures.

The Meadows sand is very similar in character to the above, and occurs as a gently sloping formation fringing the foot of the slope to the ridges. It consists of a sand of some depth, generally averaging 18 inches to the yellow heavy clay. Drainage conditions are better, due to the coarser nature of the surface soil and the slightly elevated position of the occurrences.

(b) Kuitpo gravelly, sandy loam (lateritic)—3,930 acres.—The Kuitpo series is notable for its lateritic character, and is associated with outcropping of highly ferruginous rocks commonly found on the tops of the higher ridges and at approximately the same elevation. The profile shows a grey sandy loam surface soil with some organic matter, mainly from root-decay, followed by a yellow sandy loam containing variable quantities of ironstone gravel; the subsoil is a yellow friable clay with a high percentage of ironstone gravel, passing to a yellow heavy clay with less gravel and a clay content of over 50%. The decomposing rock material from schists and quartzites appears at a greater depth than 24 inches.

Sandy loam ...		Grey
Sandy loam, varying ironstone gravel		Yellow
Friable clay, varying ironstone gravel	..15"	Yellow
Heavy clay		Yellow
Decreasing gravel	..24"	
Decomposing rock material ..		Yellow and red mottled

The subsoil is quite friable and does not appear liable to prevent water percolation nor is the ironstone gravel cemented to form a hardpan, both of which features might be thought to be the cause of the stunted vegetation usually associated with the type.

TABLE 3

Mechanical Analyses, Reaction and Nitrogen Content of Kuitpo sandy loam.

Sample No.	1920	1921	1922	1932	1933	1934	1846	1847	1848
Depth in inches ...	0–6	6–18	18–32	0–12	12–24	24–30	0–7	7–14	14–21
	%	%	%	%	%	%	%	%	%
Coarse sand .	20·8	9·4	3·2	21·8	11·8	8·1	24·0	10·0	6·4
Fine sand	38·5	20·1	12·2	37·7	18·0	14·6	45·3	18·3	14·4
Silt	14·1	11·6	13·2	9·3	9·7	11·7	11·5	10·6	12·2
Clay	22·7	51·4	63·2	25·8	53·4	59·9	16·9	55·0	59·3
Loss on acid treatment	0·7	1·2	1·2	0·5	0·8	1·1	0·4	0·4	0·4
Moisture	1·6	6·5	7·9	2·8	6·2	6·1	1·6	6·8	9·1
Loss on ignition . .	6·2	9·7	10·5	6·7	10·5	11·8	4·9	9·0	9·3
Gravel in field sample	16	5	4	30	16	12	59	17	8·5
Nitrogen	%0·05	0·04	—	0·05	0·04	—	—	—	—
pH.	5·6	5·6	5·5	5·6	5·5	5·4	5·2	5·6	5·8
Moisture equivalent .	%27·2	28·6	—	—	29·3	—	—	—	—
Sticky point	% —	—	—	—	45·9	—	—	—	—

(c) Myponga sand—4,460 acres. This type consists essentially of a deep sand over a decomposing sandstone formation. It has frequently a perfect podsolic character, one typical instance being illustrated. The surface sand generally contains an admixture of organic matter from root-decay; and beneath it is a thick layer of white leached sand; this is underlain by a band of pale yellow sand which merges into the dark-brown or black, more or less indurated layer ("coffee rock") several inches thick. The C horizon is a sandstone in stages of decomposition, the upper few inches of which may be a mottled yellow, grey, and red clay.

Sand, varying amount of Organic matter	..3"	Grey to dark grey
Sand		White
	24"	
Sand		Pale yellow
	.36"	
Sand, more or less indurated clay		Dark brown to black
	. 42"	
		Yellow and red mottled
	45"	
Decomposing sandstone		

TABLE 4.

Mechanical Analyses, Reaction and Nitrogen Content of Soils of the Myponga and Burbrook Series.

Soil Type.	Myponga sand.		Burbrook sandy loam.			Burbrook sandy loam.	
Sample No. . ..	1924	1925	2002	2003	2004	2008	2009
Depth in inches .. .	0–20	20–30	0–3	3–14	14–16	0–6	6–24
	%	%	%	%	%	%	%
Coarse sand	53·6	53·2	28·6	28·5	17·1	25·6	25·6
Fine sand	42·1	39·6	43·4	36·8	32·3	50·4	43·0
Silt	2·2	3·1	14·0	15·0	16·4	9·9	13·0
Clay	1·3	3·7	7·9	14·6	30·4	6·9	17·2
Loss on acid treatment ..	0·1	0·2	0·4	0·4	0·1	0·4	0·3
Moisture	0·1	0·1	1·6	1·7	3·9	2·5	2·1
Loss on ignition	0·6	0·7	5·7	4·2	5·8	6·2	3·7
Gravel in field sample .. .	—	—	—	23	1	3	37
Nitrogen	%—	—	0·07	0·04	—	0·09	0·04
pH.	5·2	4·7	5·4	5·5	5·8	5·2	5·4
Moisture equivalent	%—	—	—	—	—	11·9	13·3
Sticky point	%—	—	—	—	—	24·3	18·4

(d) Burbrook sandy loam—13,360 acres. The Burbrook sandy loam is by far the most extensive of the soils examined and is found generally throughout the area. It occurs extensively on the slopes and lesser hills between the high ridges of the Kuitpo soil series and the valley bottoms and is associated with every type of soil described. In profile it is typically a grey sandy loam or clayey sand with small amounts of organic matter, passing to a light grey sandy loam, often very stony; this is underlain by a buff-coloured loam or clay loam, becoming heavier to a clay and gradually merging to the C horizon. These soils varied from very shallow (3-6 inches) to moderately deep (24 inches), and from slightly stony to very stony. On the soil map the stony phase has been indicated in a number of places, but its occurrences, which depended largely on the position on hill slopes, were too numerous to show individually. The analyses are given above in Table 4.

Sandy loam to clayey sand ...		Grey
	..6″	
Sandy loam with considerable amount of stones		Grey
	...... 15″	
Loam to clay loam		Buff
	. 20″	
Clay, increasing with depth ...		
Decomposing schists and quartzites		Yellow, brown and grey mottled

(e) Kondoparinga loam—3,050 acres. The Kondoparinga series appears to be associated entirely with micaceous schist formations. It extends almost the full length of the eastern boundary of the area and is found on the more rounded hills, where conditions for agricultural development have been exploited to a greater degree than in other parts surveyed. The surface soil is a brown loam or silt loam, although in some extreme cases chocolate-brown and grey-brown colours were noted. The subsurface is brown to grey-brown, with no appreciable change in texture. At 12 to 18 inches the clay increases, passing quickly to the decomposing rock beneath. The soils are generally shallow and contain small stones which do not interfere with cultivation.

Loam or silt loam		Brown
	. 6″	
Loam to silt loam		Brown to grey brown
	12″	
Clay, increasing		Red, brown or mottled
	.15″	
Decomposing micaceous schists		

Table 5.

Some typical analyses are given in Table 5.

Mechanical Analyses, Reaction and Nitrogen Content of Kondoparinga Loam.

Sample No.	2000	2001	2005	2006	2022	2023	2024
Depth in inches	0–6	6–12	0–2	2–12	0–5	5–12	12–21
	%	%	%	%	%	%	%
Coarse sand	0·6	0·6	1·1	2·2	2·8	4·2	5·7
Fine sand	41·7	41·8	27·1	30·1	30·3	31·3	30·7
Silt	26·8	26·6	41·0	46·7	33·9	34·8	30·6
Clay	22·9	24·8	13·9	15·1	19·1	25·5	30·2
Loss on acid treatment	0·5	0·8	0·3	0·3	0·5	0·7	0·6
Moisture	2·7	2·8	9·1	2·5	5·7	2·4	2·0
Loss on ignition	7·8	6·5	10·4	5·9	11·2	7·4	7·1
Gravel in field sample	1	11	—	—	—	9	7
Nitrogen	%0·19	0·14	0·27	0·09	0·26	0·08	0·05
pH.	5·0	5·1	5·5	5·0	5·2	5·1	5·1
Moisture equivalent	% —	—	34·4	28·1	33·2	28·7	—
Sticky point	% —	—	—	—	48·1	33·4	31·8

(3) Analytical Data.

(a) Mechanical Analyses.

Certain features of the mechanical analyses have been mentioned above under the descriptions of soil types, and a selection of typical instances tabulated with each type. A summary of all the available data on the textural character of the soils is given in the summation curves in fig. 1, and the distribution triangle in fig. 2. The diagram shows clearly: *(a)* the uniformity of the Kondoparinga

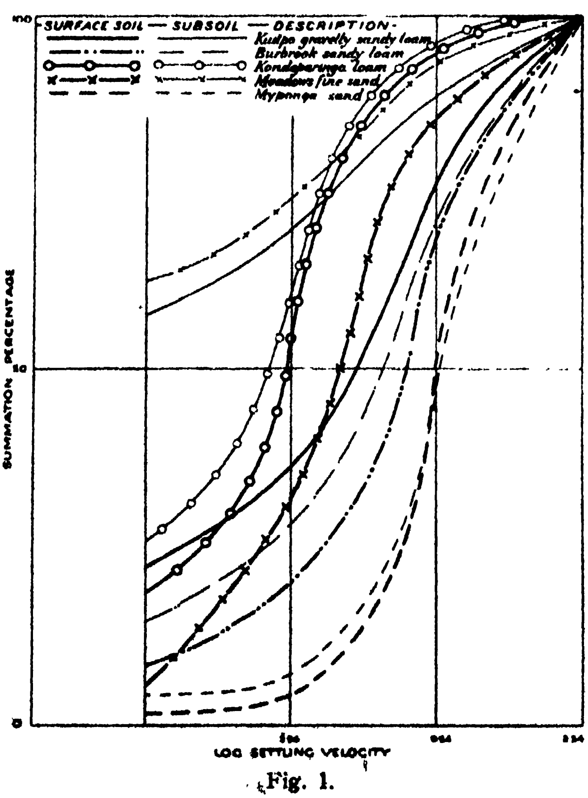


Fig. 1.

loam profile, *(b)* the wide dissimilarity between the surface and subsoil of the Kuitpo sandy loams and the concordance between samples, *(c)* the essential similarity of the Kuitpo and Burbrook sandy loam surface soils, *(d)* the complete sandiness of the Myponga sand, *(e)* the agreement between the classes of the Meadows series, *(f)* the heavy nature of the subsoils of the soils of the Kuitpo and Meadows series.

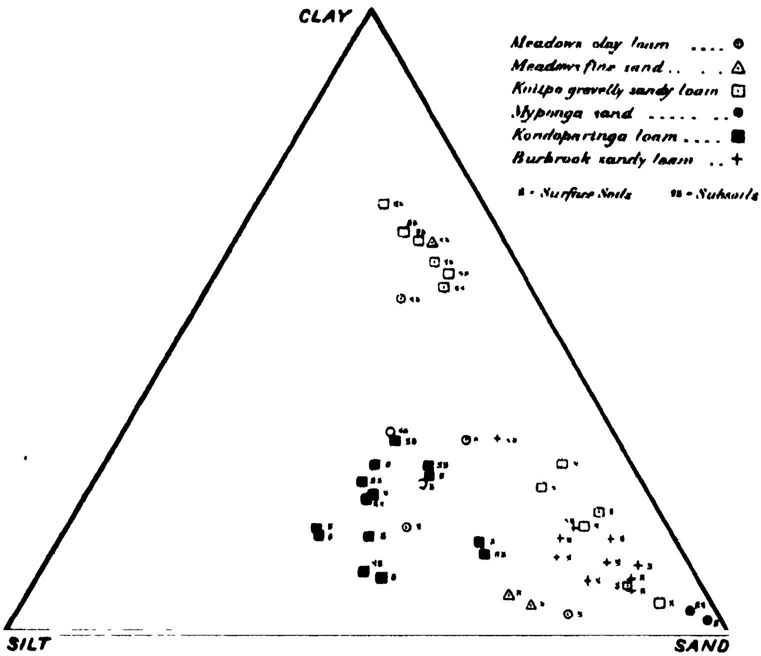


Fig. 2.

Moisture equivalents were determined for 29 soils, agreeing well with the texture, as shown by mechanical analysis.

(b) Nitrogen Content.

Most of the surface soils were examined for nitrogen content, revealing comparatively high values for the Meadows clay loam and fine sand, and the Kondoparinga loam with reasonably good figures for the subsurface soil. All the other types were low, averaging about ·04% to ·05%, except the Myponga sand, which was very low.

(c) Reaction.

All the soils, with the exception of two subsoils of the Meadows series, were definitely acid and showed no distinction in range between the soil types. The range was from pH 4·8 to pH 6·6, excluding the two alkaline subsoils, with a concentration between pH 5·4 and pH 6·0 (see Table 6).

TABLE 6.

pH Distribution Table according to Soil Series.

pH.	4.8	5.0	5.2	5.4	5.6	5.8	6.0	6.2	6.4	6.6	6.8	7.0	> 7.0
Meadows clay loam and fine sand	—	2	—	—	1	3	6	—	2	1	—	—	2
Kuitpo sandy loam	—	—	—	2	6	3	3	—	2	—	—	—	—
Myponga sand	4	—	2	—	1	4	4	1	1	—	—	—	—
Kondoparinga loam	—	3	6	4	2	3	3	—	—	—	—	—	—
Burbrook sandy loam	—	—	—	3	2	2	2	—	—	—	—	—	—

IV. RELATION OF MAJOR VEGETATION ASSOCIATIONS TO THE SOIL TYPES.

The Hundred of Kuitpo is a natural forest region, breaks in the forest only occurring where clearing has taken place and in the broad valleys. A rough division into five groups on the dominance of certain trees was possible, but further subdivision was not possible, even if desirable, owing to the virtual absence of annual communities at the time the survey was carried out. Certain areas have been modified by external agencies where extensive burning and partial clearing have removed much of the tree stratum and substituted dense thickets of banksia and sheoak. Wattle stripping and grazing have also had a considerable effect.

The five major vegetation associations and the correlated soil types are as follows:—

(a) Stringybark-Blue Gum Association.
(*E. obliqua-E. leucoxylon.*)

E. obliqua is dominant over most of the area concerned, with *E. leucoxylon*, increasing in importance on the drier slopes, and with manna gum (*E. viminalis*) occuring in the sheltered creek lines. Dense undergrowth is absent, the main representatives being *Xanthorrhoea semiplana* and *Lepidosperma semiteres*. This group is particularly allied to the Kondoparinga loam, and is largely confined to the eastern side of the area.

(b) Stringybark-Pink Gum Association.
(*E. obliqua-E. fasciculosa.*)

The components of this group, which occupies far the greatest part of the area, vary little, being approximately equal in numbers, except in the stony places, where *E. fasciculosa* is more prominent. The stringybark is only moderately large, and the pink gum rarely a good specimen. A sclerophyllous understorey of *Banksia marginata*, *Acacia pycnantha* and *Acacia myrtifolia* is underlain by a xerophytic growth of *Hakea* spp., *Pultenaea daphnoides*, *Daviesia corymbosa* and *Xanthorrhoea semiplana*. The undershrubs include *Hibbertia sericea, Platylobium obtusangulum, Tetratheca ericifolia, Colythrix tetragona, Dillwynia hispida* and *Isopogon ceratophyllus*. This vegetational type is associated with the Burbrook soil series, and to some extent with the Myponga sand, in which the stringybark is the more dominant feature.

(c) Stringybark-Cup Gum Association.
(*E. obliqua-E. Baxteri-E. cosmophylla.*)

This is a type found extensively on the flat ridge tops in the soils containing ironstone gravel. The *E. obliqua* is replaced by *E. Baxteri* to some extent in the extreme southern portion of the Hundred, and in other places the *E. cosmophylla* is dominant. The group follows the Kuitpo sandy loam closely wherever the *E. cosmophylla* is prominent.

(d) Red Gum Forests in Association with Blue Gum and Manna Gum.
(*E. rostrata-E. leucoxylon-E. viminalis.*)

The red gum forms an open forest in the broader valleys, and is of considerable extent in the northern part of the surveyed area. Fringing the actual valley bottoms, first *E. viminalis* and then *E. leucoxylon* appear with a drier condition of the soil, and an abundance of *Banksia marginata* with sporadic occurrences of *Acacia retinoides, Casuarina stricta, Hakea rugosa* and undershrubs. The group is associated with the Meadows series, the red gum on the clay loam and fine sand types especially.

(e) Manna Gum-Blue Gum Savannah in Association with Dense Sheoak and Banksia.

(E. viminalis-E. leucoxylon-Casuarina stricta-Banksia marginata.)

This association is indefinite and not so closely connected with particular soil types as the previous groups. It occurs in the northern part of the area as a peripheral band to the red gum zone, and owing to partial clearing and repeated burning the understorey of sheoak and banksia has replaced the original blue gum and manna gum such as were described in the previous group, and scattered trees only remain. In general, this vegetation is on the Meadows sand and fine sand and Myponga sand formations.

V. SOIL TYPES IN RELATION TO AGRICULTURAL DEVELOPMENT AND RE-AFFORESTATION.

In discussing the agricultural possibilities of the soils, complicating factors such as the topographical features, the vegetational cover and deficiency of water supply require recognition, all of which are peculiar to individual blocks of land. Omitting these points, the Meadows clay loam and fine sand may be considered as the best soils for intensive development on closer settlement lines, and the remainder grouped in descending value as follows:—Kondoparinga loam, Burbrook sandy loam, neglecting very stony phases, Kuitpo gravelly sandy loam, and Myponga sand. The soils of the Meadows series can be made very profitable with intensive treatment. For general grazing purposes the Kondoparinga loam is outstanding, especially the lower slopes, which carry very good pasture. The Burbrook sandy loam appears to yield satisfactory results when sufficiently cleared and a pasture of Subterranean Clover laid down, but it affords one instance where secondary factors influence development, as this country is covered by a relatively dense scrub forest containing little timber of value and in addition is frequently on steep and stony slopes. The Myponga sand is a poor soil, as evidenced by the natural stunted heath cover in the south and the poor timber of Knott's Hill area in the north. It is probable that improvement would result from a Subterranean clover pasture, which can be established on cleared areas. The Kuitpo sandy loam affords the most interesting type, probably agriculturally poor, although no attempt has been made as yet to develop any area of it.

The question of re-afforestation with conifer plantations is of major importance in this portion of the Hundred of Kuitpo, since over 40% of the area is held as forest reserve and 14% is already cleared and planted. Some soils are naturally suited to re-afforestation rather than grazing, and it would appear that considerable areas come into this class. If it be possible to plant soft woods profitably on the Kuitpo, Myponga and Burbrook types, there seems ample justification for their development in this way. Much of the country at present planted on Myponga sand is giving poor results, but the Burbrook soils are much better suited to the various Pinus spp. The Kuitpo type has not yet been used to a sufficient extent either agriculturally or for timber purposes to show its value. The soils of the Meadows and Kondoparinga series should be regarded as too valuable for timber alone.

VI. SUMMARY.

(1) An account has been given of the soils, their classification and distribution in the southern half of the Hundred of Kuitpo.
(2) The soils are grouped into five series and seven soil types.
(3) Mechanical analyses, reactions and nitrogen content of the soils are tabulated and discussed.
(4) The relation of soil type to natural vegetation, to agricultural development and to re-afforestation is briefly noted.

ACKNOWLEDGMENTS.

The authors are indebted to Mr. P. D. Hooper for assistance in the field and for the cartography, to Messrs. T. J. Marshall and N. J. King for field assistance, and to the Forestry Commission of South Australia for information and making available facilities in the field.

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SOME CHARACTERISTICS OF SOILS USED FOR TURF WICKETS IN AUSTRALIA.

By C. S. Piper
(Waite Agricultural Research Institute, University of Adelaide).

[Read November 12, 1931.]

Early in 1931, the Federal Capital Territory Cricket Association desiring advice on the suitability of certain soils for the establishment of turf wickets at Canberra, the author undertook an investigation into some of the chemical and physical properties of those soils which have been successfully used on the more important cricket grounds of Australia. The soils are all of a characteristic type (heavy black clays), and the purpose of the present paper is to place their description on record.

Description of the Soils.

No. 2200 Bulli,
No. 2201 Hamilton,
No. 2202 Toongabbi, } N.S.W. — These soils are dark-grey to grey-black in colour and are all heavy clays. The Hamilton soil is used on the Sydney Cricket Ground, and the other two are extensively used for metropolitan wickets.

Nos. 2203, 2204 Athelstone, S.A. — The two samples from Athelstone are very similar, being heavy black tenacious clays of alluvial origin. The former sample represents the soil used for the wicket on the Adelaide Oval, while the other sample is thought to be slightly better

No. 2205 Merri Creek (Brunswick), Vic. — This is a heavy black clay of volcanic origin. The air dry soil was the most tenacious in the whole series. This soil is used on the Melbourne Cricket Ground, and the wicket is said to be the most dangerous in Australia during the first two hours' play.

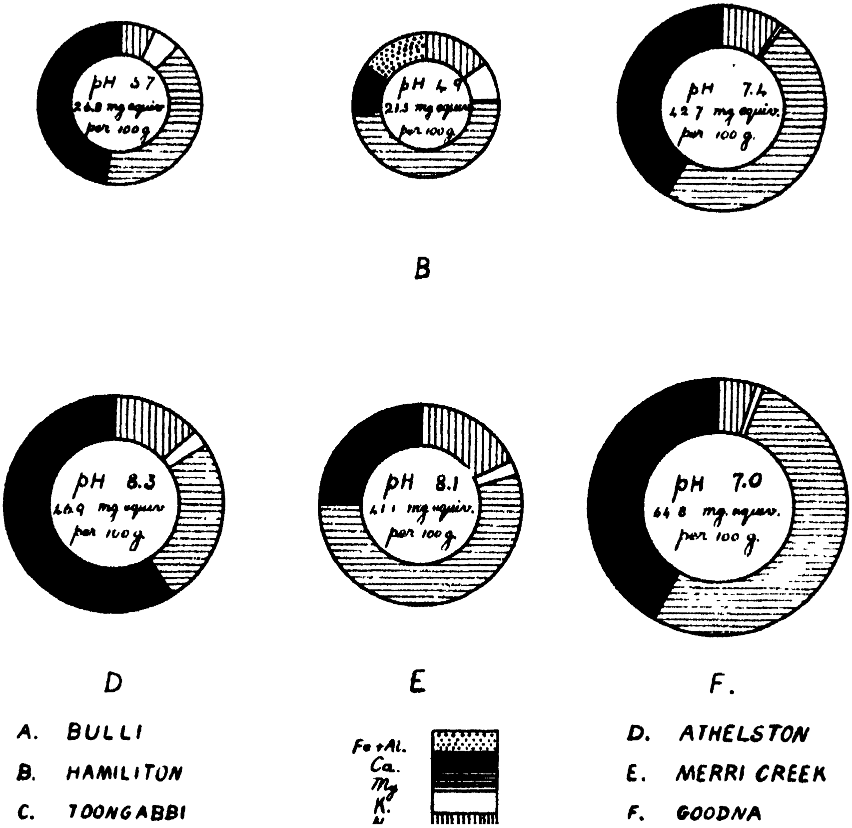
No. 2319 Goodna, Qld. .. .. — This soil resembles the previous three samples in colour and texture. It represents the soil used for the wicket on the Brisbane Oval.

Analytical Results.

The analytical results are given in detail in Table 1. It will be seen that all the soils are characterised by their very high clay content, ranging from 55% to 73%. Stones and gravel (particles greater than 2 mm. diameter) are almost entirely absent, and the coarse sand fraction is also quite small. Associated with the high clay content, high values are also found for "moisture equivalent," and "water holding capacity." The value for the moisture equivalent of the Merri Creek soil (65%) is probably a little too high, as the soil did not reach equilibrium in the usual 30-minute period of centrifuging. The volume expansion on wetting the soils is also very considerable, especially in the case of the soils with an alkaline

reaction. This large volume expansion implies very considerable shrinkage and cracking as the soils become dry. So long as this cracking is of a somewhat cubical nature it is not deleterious, but soils which break up easily into an irregular crumb structure (self-mulching types) are unsuitable for the preparation of turf wickets.

The presence of calcium carbonate would tend to make a soil friable, and for the purpose for which these soils are required it is desirable that it should not



be present in quantity. Such is found to be the case, calcium carbonate being either entirely absent or quite low in amount, the largest quantity (0·5%) occurring in the Merri Creek soil. As it occurs mostly in the form of small nodules scattered throughout the soil, even this quantity is not serious. Organic matter also affects the field texture of a soil, but the amount found in these samples (2–9%) shows that it can vary widely without affecting the value of the soils for turf wickets. The colour of the soil is no indication of the amount of organic matter, since some of the darkest soils contain the least. The soils of acid reaction are significantly richer in organic matter than those with higher pH values. The carbon : nitrogen ratio is rather wide and approximates 17·4 : 1 in all the soils except that from Bulli (ratio, 14 : 1); any influence of climate on the carbon : nitrogen ratio cannot be detected.

Exchangeable bases have been determined in six of the seven samples. The amounts and relative proportions of each base are given in Table 1., and are also

TABLE

Physical and Chemical Characteristics of Australian Turf Wicket Soils.

		N.S.W.			S.A.			
Locality .. .			on		elstor	Athelstone		
Soil No. .. .					203	204		231
Soil Reaction	pH	5·7		7·4	8·3	8·[illegible]	8·1	7·0
		%		%	%	%	%	%
Calcium Carbonate	$CaCO_3$	nil	nil	0·02	0·26	0·6[illegible]	0·54	0·01
MECHANICAL ANALYSIS—								
Coarse sand	..	5·9	1·2	2·7	7·6	3·5	2·9	0·7
Fine sand	..	15·1	5·2	15·7	22·8	23·8	16·3	12·2
Silt	..	23·4	20·7	13·2	13·6	12·7	13·0	16·1
Clay	..	55·6	72·9	68·4	56·0	60·0	67·8	71·0
		100·0	100·0	100·0	100·0	100·0	100·0	100·0
Moisture equivalent	..	41	41	57	48	51	65 (high)	70
KEEN-RACZKOWSKI BOX CONSTANTS—								
Apparent S.G. of air dry soil ..	..	1·18	1·09	1·29	1·37	1·36	1·23	1·23
Amount of water absorbed by 100 parts of dry soil		68	67	87	66	69	79	108
Volume expansion on wetting	..	21	13	46	32	36	45	63
Moisture in air dry soil	..	8·2	7·4	11·6	9·2	10·3	10·9	12·3
Nitrogen " " "	..	0·37	0·25	0·13	0·08	0·07	0·15	0·16
Organic Carbon " "	..	5·18	4·51	2·26	1·54	1·17	2·67	2·78
Equivalent to Organic Matter	..	8·9	7·8	3·9	2·7	2·0	4·6	4·8
		m.e. per 100 g.	m.e. per 100 g.	m.e. per 100 g.	m.e. per 100 g.		m.e. per 100 g.	m.e. per 100 g.
EXCHANGEABLE BASES in air dry soil—								
Iron + Aluminium	Fe + Al	0·3	3·4	—	—		—	—
Calcium	Ca	12·5	2·4	17·8	27·7		10·3	27·4
Magnesium	Mg	10·8	10·4	20·7	11·9		22·6	34·0
Potassium	K	1·5	1·8	0·2	1·2		0·9	0·4
Sodium	Na	1·7	3·3	4·0	6·1		7·3	3·0
otal Bas .. .	..	26·8	21·3	42·7	46·9		41·1	64·8
EXCHANGEABLE BASES. Relative pe tage proportions—								
Iron + Aluminium	Fe + Al	1·1	15·8	—	—		—	—
Calcium ..	Ca	46·7	11·4	41·7	59·1		25·1	42·3
Magnesium ..	Mg	40·3	49·0	48·5	25·4		54·9	52·5
Potassium ..	K	5·6	8·5	0·4	2·5		2·1	0·6
Sodium ..	Na							

shown diagrammatically in fig. 1. The area of each circle has been made proportional to the total amount of exchangeable bases (in milligram equivalents) in each 100 grm. of soil. It is seen that the soils are essentially magnesium-calcium clays, magnesium constituting nearly 55% of the total bases in the Merri Creek and Goodna soils. The proportion of sodium is also significant in the case of the Merri Creek soil. The total amount of exchangeable bases is, as would be expected from the clay and organic matter content of the soils, relatively high. The amount of exchangeable hydrogen in the soils of acid reaction has not been determined. Traces of exchangeable manganese (less than 0·1 milligram equivalents per 100 grms.) were also found in these latter.

Conclusions.

Soils used for turf wickets in Australia have been examined, and their outstanding properties have been shown to be the high clay content and the practical absence of calcium carbonate.

In conclusion, the author desires to thank the various State Cricket Associations for collecting and forwarding the samples of soils.

ADELAIDE UNIVERSITY FIELD ANTHROPOLOGY, CENTRAL AUSTRALIA.

No. 10.—THE ASTRONOMY OF THE ARANDA AND LURITJA TRIBES.

By B. G. Maegraith, M.B., B.S.

[Read May 12, 1932.]

As a special feature of the ethnological make-up of the Australian aborigine, Astronomy does not seem to have claimed its full share of attention, notwithstanding its significance in the study of other peoples. Many legends concerning the heavenly bodies have been handed down or have found their way into popular books of aboriginal myths, but the actual recorded astronomical observations of the aborigine have not been very carefully investigated. During the stay at Hermannsburg, Central Australia, of the 1929[1] expedition of the Board of Anthropology of the University of Adelaide, the writer made an attempt to acquire as much as possible of the natives' knowledge of stars and star groupings. The following paper is a summary of the information thus secured, the material being obtained from old Aranda and Luritja men.

In order to prevent their collusion, the old men were interrogated separately, each through a different interpreter. Only such information as was common to all accounts of the heavens is included here.

The expedition spent August, 1929, at Hermannsburg, and astronomical investigations were carried out in the evenings between 8 p.m. and 11 p.m., so that only little more than half of the sky could be mapped out. Owing to the difficulty of obtaining volunteers to rise in the early hours of the morning, several important constellations, including Orion and Taurus, were not examined. A large amount of heterogeneous information was obtained, however, and is included in a special section of this paper.

The August heavens in Central Australia command the attention of the observer, presenting, as they do, a brilliant spectacle of scintillating points of light suspended in a dark, deep purple background. The richest part of the Milky Way stretches across the sky from the south to the north, passing through the constellations of the Ship Argo, the Cross, the Centaur, the Scorpion, the Archer, the Eagle, and the Swan.

The Lyre may be seen in the north-west on the flank of the Swan, while Achernar and Canopus appear in the south-eastern sky. Almost vertically overhead are Grus the Crane and Pavo the Peacock.

To mark out the configuration of the constellations is by no means easy even to an educated observer, and the aborigine has not generally adopted the idea of tracing out a figure amongst the stars, a single star usually representing a whole animal or its track. However, as will be explained later, the aborigine has complicated his star groupings by the introduction of marriage classification and relationship, and by tribal divisions.

The sky is portioned out into two great "camps" separated by the Milky Way, which is supposed to be a river or creek. All stars to the east of this celestial river

[1] Assisted by a grant from the Australian National Research Council.

are spoken of as Aranda "camps," and all stars to the west are called Luritja "camps." The stars constituting the Milky Way are said to be a mixture of Aranda and Luritja "camps," containing many women.

This division of the stars into tribal groups is further complicated by the introduction of marriage classes and of class relationships between the various stars and constellations.

Stars and Constellations.

For the purpose of this paper the stars have been divided into groups in the following manner:—

(a) Stars in the region of the Southern Cross and in the south and south-east.

(b) Stars in the region of Scorpio.

(c) Stars in the northern portion of the Milky Way and west of the Milky Way.

Each division will be considered in turn.

(a) Stars in the Region of the Southern Cross.

The rather obvious grouping of the four principal stars in the constellation of the Cross has not been appreciated by either the Aranda or the Luritja.

The aborigine has selected the bright second- and third-magnitude stars Gamma and Delta Crucis and has arranged them, along with the less prominent stars Gamma and Delta Centauri, into what is practically the only definite native constellation drawn among the stars visible at the time of investigation. This irregular, quadrangular arrangement of stars is termed Iritjinga, the Eagle-hawk. On being asked which stars represented the wings, head, legs, etc., of the bird, the aborigine's response was always to the effect that the group of stars as a whole represented the hawk, no star separately indicating any particular part of the bird's anatomy. Strehlow[(2)] applies this name Iritjinga to the Southern Cross itself, but this seems to be incorrect, as all the informants at Hermannsburg, without exception, drew a sharp distinction between the stars of the Cross and the group described above as the Eagle-hawk.

No other organised grouping of the stars in the region of the Southern Cross seems to have been made, but it is in this region that the complicated system of marriage classifications is most in evidence. Although at first sight it may appear that the classes and tribes have been mixed indiscriminately, closer investigation shows a definite and ordered arrangement of these social systems.

The stars Alpha and Beta Crucis are believed to be the Luritja parents of another star, the upper Pointer, Alpha Centauri. Beta Crucis is a male belonging to the class corresponding to Knaria, and Alpha Crucis is his lubra, a woman belonging to the class Ngala. Their child, the upper Pointer, Alpha Centauri, is a Paltara boy. No legend connecting these three stars was obtained except that they lived together in the creek Ulbaia, the Milky Way. The combination of Knaria-Ngala parents and a male offspring will be seen to be strictly in accordance with the marriage class system.

The other Pointer, Beta Centauri, is a cousin of the Paltara man Alpha Centauri, and belongs to the class Mbitjana. He is an Aranda man, and is the son of Aranda parents, Alpha and Beta Trianguli, who belong to the Ngala and Knaria marriage classes respectively (the sexes being in the reverse order to the

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(2) Strehlow, Karl. "Die Aranda und Loritja Stämme in Zentral Australien." . . . von C. Strehlow . . . Frankfurt, 1907.

above), and who lie to the east of the Milky Way in the Aranda part of the heavens.

It will be noticed that in the above grouping of stars the division into Aranda and Luritja, depending upon the relation of the stars to the east or the west of the Milky Way, has been adhered to strictly; *e.g.*, the stars Alpha and Beta Crucis, lying to the west of the galaxy, are classed as Luritja, whereas the stars Alpha and Beta Trianguli, which lie to the east, are classified as Aranda.

The brilliant star Achernar (Alpha Eridani), which at this time of the year is high above the eastern horizon, is believed to be a big Aranda camp, containing many men sitting round a great fire. The aborigine thinks that the star is really the light of this camp fire away in the distance.

Musca, the fly, a small quadrangular constellation to the east of the Cross, was referred to as a "mob" of Aranda camps.

The principal stars visible in the south-east and east, namely, Alpha Piscis, Alpha Pavonis, and Alpha and Beta Gruis, are well recognised but have no individual names, being merely big Aranda "camps," where the old men are sitting round the camp fires.

Many of the smaller stars in the region of the Southern Cross and the Centaur were pointed out as either Aranda or Luritja camps, but these appeared to have no specific names or family groups. There was always the same definite, clear-cut division between the stars belonging to the two tribes, those in the east being invariably Aranda, those in the west invariably Luritja.

No particular attention seems to have been paid by the aborigines to the Magellan Clouds.

(b) Stars in the Region of Scorpio.

The brilliant constellation of the Scorpion, which is almost vertically overhead during the early evenings of August in Central Australia, seems to have aroused the observation of the aborigine. This is to be accounted for not only by the brightness of its stars, but also by the ease with which the old men could lie and watch it from their huts.

The native has dissected the constellation as we know it into two groups, cutting off the stars in the head from those in the tail, and adding to the latter some of the smaller stars of Sagittarius. It seems characteristic of native astronomy that it is not necessarily the brightness of a star that attracts attention to it, as in some instances stars of second and third magnitude are ignored whilst much fainter stars in the immediate neighbourhood are not only named but given marriage classification as well.

In the constellation of the Scorpion the stars Lambda and Upsilon, near the end of the tail, are supposed to be the tracks of a Panunga man and a Parula woman, respectively. Both these, lying to the east of the Milky Way, belong to the Aranda tribe. The much smaller stars Iota and Kappa Scorpii, situated in the bend of the tail, are believed to be the tracks of two other Panunga men.

The straight line produced by joining Kappa and Iota Scorpii to Beta Sagittarii, lying to the east, represents a spear. This is a curious anomaly, as the two stars, Iota and Kappa Scorpii, are thus brought into the formation of two entirely different groups of stars. There is, however, a legend connecting all these stars into the one picture.

The two Panunga men, Iota and Kappa Scorpii, come from the Aranda camp on the dry bed of the creek Ulbaia (the Milky Way). Armed with boomerangs and spears, they are pursuing the third Panunga man, Lambda Scorpii, who is eluding their vengeance with the Parula woman, Upsilon Scorpii, whom he has

stolen from the pursuer, Iota Scorpii. The spear described above is the weapon of one of the pursuers. The small stars, Eta and Zeta Scorpii, which lie close together in the first bend of the tail of the constellation, indicate the tracks of the escaping couple, where they were overtaken and slain by their pursuers. The legend then goes on to tell how the victors returned to the camp with the bodies and buried their brother and the woman in the creek Ulbaia, digging the grave with a yam stick, which may be seen to this day by joining Theta Scorpii to Alpha and Beta Arae in the south.

The principal star of the modern constellation of Scorpio, Alpha Scorpii (Antares), is distinguished by the Aranda as the Arka, or "tickly woman." Arka is supposed to be flying west from the Aranda camp in the creek, to escape the attention of the men. She is taking with her two other Aranda women, lying on either side of her, Tau to the east and Sigma to the west. Arka belongs to the marriage class Ngala, and her companions to the class Mbitjana.

Antares was also described as Alknarinja, the "red ochre woman," who is proceeding from the creek with her yam stick towards a group of young women in the west (called Orarkwa, probably the Hyades), with whom she collects "tucker," including grubs, and returns with them to the creek Ulbaia.

Three other stars in this vicinity, namely, Beta, Delta and Pi Scorpii, lying in a line roughly north and south, are supposed to be three Luritja sisters, who are returning to the creek from a big camp in the far west, below the horizon. These women are supposed to meet Arka flying westward, and to be persuaded by her to turn back, thus explaining their position in the western extremity of the constellation.

(c) Stars in the Northern Portion of the Milky Way.

The stars of the constellations which lie to the north of Scorpio shine out clearly in the Central Australian night air, and have received quite as much attention from the natives as have the more brilliant southern stars.

Altair (Alpha Aquilae), the brightest of the constellation Aquila, the Eagle, and its immediate neighbour, Beta Aquilae, represent the tracks of two blackfellows (marriage classes not known) who are pursuing an emu, Kalaia. The emu's tracks are seen in the sky as Vega (Alpha Lyrae), the brightest star of the constellation Lyra, the Lyre, and Eta and Pi Herculis, two small stars lying close together low down in the north-west.

Alpha Aquilae (Altair) and Beta Aquilae (Alshain) are supposed to be the tracks of two brothers belonging to the Luritja tribe, who in ancient times hunted the emu across the sky. With boomerangs for weapons they pursued the emu from the creek to a spot low down in the far western sandhills, where they caught and killed their victim and returned with it to the camp of their father and mother, who were both Luritja. The Luritja man whose track across the sky is represented by Alpha Aquilae was supposed to be right-handed, and his brother, represented by Beta Aquilae, left-handed.

Apart from the stars specifically mentioned above, all the small stars in the constellations of Aquila, Hercules, Lyra and Ophiucus are supposed to be tracks of these two Luritja hunters and their prey. The small stars Beta and Delta Cygni, lying low down in the northern end of the Milky Way, are believed to represent the tracks of two old Knaria men, who are respectively brother and uncle of the above hunters, Alpha and Beta Aquilae. These two old men followed the hunters at a distance and assisted them to carry the emu back to the creek Ulbaia.

Another version of this story, told by an old Aranda man, was as follows:— The two blackfellows, Alpha and Beta Aquilae, who are pursuing the emu, catch

him in the west in the hot weather (*i.e.*, after these constellations have set), kill him, and drag the body back to the camp, where they cook him at once. Unfortunately, a spirit or mamu smells the roasting emu meat, comes out of the creek bed and frightens the hunters away. The mamu then disappears inside the earth with the stolen meat. The blackfellows return and chase another emu. The bird is killed and the meat cooked, but the mamu steals it again, and so on, the performance being repeated yearly and never finishing.

Arcturus (Alpha Bootis) is the only other star visible in the north that has received a name. It is believed to be a Panunga man of the Luritja tribe.

Stars Not Visible During August Evenings.

The above is a more or less detailed account of the stars that were visible in the evenings during the stay of the expedition at Hermannsburg, but there was also obtained a large amount of interesting information concerning those constellations, such as Orion and Taurus, which were not visible at the time. The material that was collected is not quite reliable, therefore only a small portion can be included here.

The principal constellations which were not in view were those which are best seen in the summer months of the year, and which in August rise about 11 p.m. and later. It was owing to the aborigine's instinctive dislike of moving about after dark, and his consequent refusal to stir in the early mornings, that more complete and detailed evidence was not obtained. In spite of this, the native seems to have watched the stars from the shelter of his camp, as will be gathered in discussing the aboriginal knowledge of star motion.

As in the case of the Southern Cross and Scorpio, the modern grouping of stars based on brilliance and position has not been followed, except on very broad lines. Nevertheless, the same principles of native nomenclature hold here as for those stars described above, marriage classes and tribal relationships being strictly followed, with a further complicating addition of an apparent relationship depending on stellar colour.

The first group of importance among the stars not seen during the expedition seems to be the Hyades, portion of the modern constellation of Taurus, including also the bright red star Alpha Tauri (Aldebaran), the eye of the Bull. The native describes this group as being the tracks of a party of women, who are "cousins," being of equal numbers (described as a "handful" of each). These "cousins" are young girls who are "not yet lubras," and half of them are Mbitjana and the other half Paltara. The Mbitjana girls are called tataka, *i.e.*, red. The Paltara girls are called tjilkera, *i.e.*, white. They are arranged in two rows, facing one another, this arrangement giving the clue to their modern equivalent, the Hyades, which is a V-shaped group of stars with Aldebaran at the extremity of one of the limbs of the V.

The Mbitjana girls, the red stars, belong to the Aranda tribe, and are the off-spring of two other red stars, an old Ngala man named Kartaljana, probably Aldebaran, and an old Knaria woman, whose name and position were not ascertained.

Kartaljana was described as being tataka indora, meaning very red, and his lubra as being tataka tjilkera, *i.e.*, red-white. Both these stars are supposed to be Aranda, their children also being Aranda.

The Paltara girls of the Hyades have for their father the "daylight-star," presumably Venus. This parent of the girls is given the name Ngarnadi, and belongs to the marriage class Knaria. His wife is a star (not identified) called

Itna Turgi, belonging to the marriage class Ngala. Both these stars are Aranda, and the Paltara girls belong to the same tribe.

Another portion of the constellation Taurus, the famous Pleiades, or Seven Sisters, is considered to be the tracks of a group of young girls, also "not yet lubras." This group receives the name of Kuralja, but is given no marriage classification.

The brilliant constellation Orion is believed to consist of two groups, one of old men of the Ngala class, and the other of old women of the Knaria class.

Many other stars and star groups were mentioned by the aborigines, but these the writer was unable to identify.

The General Astronomy of the Aranda and Luritja.

Modern astronomy, with all its improved methods of observation, owes its great advances to the desire on the part of its founders not only to discover facts but to interpret them. This characteristic of human thought is exhibited in a primitive way in the aborigine, whose conception of astronomy seems to have followed somewhat the same lines of development as our own. The aborigine has gone beyond the stage of merely mapping out the stars into groups and painting fantastic stories in the sky. In a way, he may be said to have tried to analyse the physical features of the stars and to have noted such attributes as their motion and degree of magnitude.

The most interesting fact about aboriginal astronomy is that all the adult males of the tribe are fully conversant with all that is known, while no young man of the tribe knows much about the stars until after his initiation is complete. As children the boys learn "unofficial" stories of the stars from their mothers, thus imbibing, as it were, the vague astronomy of the women. When they grow up and have undergone their ceremonial circumcision, they are taught the "truth" about the tribal legends and names of the stars. The old men are the teachers, the women being shut out from any knowledge of the legends and names handed on to the boys. The old men also instruct the initiated boys in the movements, colour and brightness of the stars.

In view of his inborn reluctance to stir after dark, the aborigine's general knowledge of the stars is surprising.

Movements of the Stars.

The aborigine has differentiated between the two apparent motions of the stars through the year, namely, the nightly movement from east to west (similar to that of the sun in the day), and the gradual annual shift of the constellations in the same direction.

As an illustration of these apparent stellar motions the previously mentioned constellation Iritjinga was taken, and its positions in the colder months of the year and later in the evening were correctly described. To foretell accurately the position of a constellation through the night and throughout the year requires a good knowledge of stellar topography and movement, and serves to show the aborigine's keen powers of observation.

A still further stage has been reached by the aborigine, for he has noticed that certain stars lying to the south are always visible at night, although their position in the sky alters with the seasons. For instance, the writer was told that Iritjinga and the Pointers were always to be seen, although they were sometimes high up in the sky and sometimes low down. This, of course, amounts to the discovery that stars within a certain distance from the south celestial pole never fall below the horizon. Curiously enough, the native has not taken the logical step

forward and applied his knowledge to the art of finding his way at night, though his fear of the dark may be the explanation of this mental backwardness. Nor has the fact that the stars mentioned are always roughly in the same quarter of the sky stimulated his sense of direction, for no Central Australian native can find his way by night by reference to the stars, although in the daytime he possesses the utmost skill in respect of location.

Stellar Magnitude and Colour.

The aborigine has grouped the stars into legends, marriage classes, and so on without much regard for our standards of stellar magnitude. As was mentioned in describing the aboriginal constellation Iritjinga, it does not always seem to be the brightness of a star that attracts his attention to it. It frequently happens that bright stars in close proximity to one another are arranged in different groups, and are intimately linked up with insignificant and distant stars. A good example of this peculiar disregard for stellar brightness is to be seen in the constellation Iritjinga. In this group the first magnitude star, Alpha Crucis, and the second magnitude star, Beta Crucis, are connected by their marriage classes with the great Pointer Alpha Centauri, whereas the bright stars Gamma and Delta Crucis are grouped with the less luminous stars Gamma and Delta Centauri, in disregard of their closer proximity to the brilliant stars Alpha and Beta Crucis.

This apparent indifference to the obviously natural grouping of bright stars suggests that other things besides brilliance may appeal to the aborigine's mind, and it is interesting, therefore, to note that there seems to be some definite selection according to colour.

There is no doubt that the Aranda and Luritja natives have a good colour sense. It is not surprising, then, to find that the bright star Alpha Scorpii (Antares) is designated as being tataka indora (very red). The colours of much less brilliant stars have also been observed. For example, in the Hyades constellation, which, as stated above, has been split into two groups representing cousins of Mbitjana and Paltara classes, the two groups are referred to as tataka (red) and tjilkera (white), respectively. In the case of the Hyades there seems to be some correspondence of colour and classification, for the parents of the red Mbitjana girls are both red stars, though in the case of the group of Paltara cousins the colours of the parent stars were not stated.

In general, only two colours are described in the stars, namely, tataka (red) and tjilkera (white). Blue stars and yellow stars seem to be known as tjilkera. The natives can always describe in this limited sense the colour of a star pointed out to them, but in the case of the Hyades the colours apparently possess more than a mere descriptive importance.

Summary.

The above paper demonstrates the comparatively high degree of astronomical knowledge possessed by the Central Australian aborigine, as represented by the Aranda and Luritja tribes. The curious similarity between the astronomies of the two tribes is possibly due to their frequent intermingling and their apparently peaceful associations, or perhaps to a common traditional lore or source of information.

Astronomical names and legends are not the products of individual native imagination, but are the result of tribal observations going back to ancient times. The knowledge is handed down by the old men to the boys at their initiation, and is carefully concealed from the women, who know practically nothing about the stars.

In addition to receiving names and figuring in tribal legends, stars are put into definite marriage groups and maintain strict group relationships. Although

eight marriage classes occur in the Aranda social system, six only seem to have been applied to the stars, viz., Ngala, Knaria, Paltara, Mbitjana, Panunga and Parula.

There is no projection into the stellar system of any individual native's class or totem. For example, no native has his own particular star, and the star representing the emu has no special significance to a man of the emu totem.

The Milky Way divides the sky into Aranda and Luritja parts.

In general, the figured constellation is rare in aboriginal astronomy, a single star representing a whole animal or its tracks. The apparent motions of the stars have been studied and differentiated. The continuous presence above the horizon of certain southerly stars has been observed, but the knowledge has not been applied to determine direction at night. No explanation of stellar movements is known. The colour and degree of brightness of stars have been noticed, but groupings of bright stars which are natural and obvious to the civilised eye have frequently been split up by the aborigine and associated with less brilliant and more distant stars. There seems to be some correlation between colour and family grouping. The legends concerning the sun and the moon are the same as described by Strehlow, and need no repetition here. There appears to be no definite knowledge of the presence of wandering stars, *i.e.*, planets. The nature of the stars and the earth is not understood, but their existence is explained by legend.

ADELAIDE UNIVERSITY FIELD ANTHROPOLOGY.
CENTRAL AUSTRALIA.

No. 11.—GENEALOGICAL STUDIES OF AUSTRALIAN TRIBAL SYSTEMS.

By H. K. Fry, M.B., B.S., B.Sc.

[Read June 9, 1932.]

A method of tabulating the eight classes of the Aranda tribe in their genealogical relationships has been described (6) in a previous paper, and the morphological characteristics of this genealogical pattern discussed. This study has made it possible to draw up tables of hypothetical tribal systems representing variant or more elaborate exogamous subdivisions. Such tables, which were originally of theoretical interest only, would now appear to be of practical value in the study of tribal organisations.

One such instance is Spencer's description (1) of the Mangarai tribe as consisting of eight classes, with a further subdivision of each class into two or four individual totem groups, twenty-six (and probably more) in all. Class marriage and descent are recorded as following the normal rules of an eight-class system with an additional recognition of the totemic sub-groups as exogamous units. This suggests that this tribe may represent a social organisation based on the genealogical pattern of a system of thirty-two exogamous subdivisions.

Spencer has supplied ten examples of Mangarai marriage and descent, and it has been a matter of interest to see if these data can determine the genealogical pattern of the tribal organisation. The terms concerned in each of Spencer's examples were set down in the convention adopted in the preparation of the Aranda tables, that is "son" below "father" and "daughter" below "mother." These family groups were then built up into genealogical sequences of direct male and female descent as far as possible. A difficulty was encountered in dealing with the Tjabijin, Ngangiella terms. One series in male descent is provided:—Tjabijin, dingo: Ngangiella, plain-wallaby: Tjabijin, opossum. Two other single examples give Ngangiella, goanna: Tjabijin, lily: and Tjabijin, pelican: Ngangiella, black-snake. The latter are incompatible with the genealogical sequences of an eight-class system, either in relation to one another or in relation to the former series. If pelican be substituted for lily (or vice versa, it is immaterial which for present purposes), all the class names will conform to the normal eight-class pattern, a condition which Spencer confirms elsewhere (2). This amendment, therefore, appears legitimate, and has been adopted.

Spencer's only example of a double marriage is an important one. "A Ngapalieri man of the water-plant totem marries a Nakomara woman of the paddy-melon totem, and their children are Ngabullan and poison-snake; a Nakomara of the paddy-melon totem marries a Ngapalieri woman of the brush-tailed wallaby totem and their children are Ngaburella and porcupine." This is an instance where brothers do not exchange sisters in marriage, which is an unusual arrangement but is exemplified in other tribes, *e.g.*, the Murngin and Karadjeri. If the Mangarai system were based upon only four lines of clan descent, this marriage would have to be represented, using the symbolism explained under

Tables 1 and 2, as a1 marries B1, b1 marries A2, or vice versa. The remaining data will not conform to the consequences of such an arrangement. It is, therefore, necessary to double the Aranda type of table and recognise eight lines of descent. This theoretically permits of the double marriage being represented either as:—a1 marries B1, b1 marries A3; or as, a1 marries B2, b2 marries A3. By the trial and error method it was found that the latter form only would conform to Spencer's data. It was also found that this form of marriage could not occur in each generation without violation of other data. A table of this type will be represented if lines 2. and 3. be omitted from Table 2, and will be found to permit marriages with "mother's brother's daughter" and not with "father's sister's daughter."

All the data will be satisfied by the pattern of Table 1, where the marriages of alternate generations are of the types:—a1 marries B1, b1 marries A1, so allowing of sister exchange; and a1 marries B2, b2 marries A3. Table 1 was drawn up originally to illustrate a type of marriage, described as characteristic of the Ungarinyin tribe (3), in which a man is permitted to marry his father's mother's brother's son's daughter but not his mother's mother's brother's daughter's daughter, both of which are marriageable relations in the Aranda tribe.

If line 4. of Table 1 be altered to:—

4. a1 B4 b1 A2 a2 B3 b2 A1 a3 B2 b3 A4 a4 B1 b4 A3,

a system will be illustrated in which a man can marry his mother's mother's brother's daughter's daughter but not his father's mother's brother's son's daughter. Spencer's data will not fit this pattern. The type marriages in this case are interesting, however. They are as follows:—1. a1 marries B1, b1 marries A1; 2. a1 marries B2, b1 marries A4; 3. a1 marries B3, b1 marries A3; 4. a1 marries B4, b1 marries A2.

One other table has been found to satisfy all Spencer's data, and is given in Table 2. In this table, in generations 2. and 4., b1 marries A2, instead of A4 as in Table 1. The pattern is remarkably different from that of the latter, taking eight generations to complete the cycle and permitting marriages of the Aranda type.

The alternative marriages of a2 in generations 2. and 4. are indifferent. In Table 1, a2 marries B1; in Table 2, a2 marries B3. The latter marriage makes sister exchange illegal with both "a" and "b" units, and is, therefore, more consistent than the former.

If in Table 2 the type marriages of generations 3. and 4. be altered so that the series becomes:—1. a1 marries B1, b1 marries A1; 2. a1 marries b2, b1 marries A2; 3. a1 marries B3, b1 marries A3; 4. a1 marries B4, b1 marries A4, then a table will result illustrating a system which will not permit marriages with either of the marriageable kin of the Aranda type. Spencer's data will not fit this pattern.

If in the above tables the marriages:—a1 marries B1, b1 marries A1, be altered to:—a1 marries B3, b1 marries A1, symmetrical tables can be drawn up in which analogous sequences of type marriages will each express an analogous kinship pattern, but such systems will not allow "sister exchange" in any generation. For example, in relation to such marriages, if 2. a1 marry B2; b1 marry A2, the kinship type of Table 1 will result; if 2. a1 marry B4, b1 marry A2, the kinship type of Table 2 will result, etc. Spencer's data will not conform to any of these tables.

This appears to exhaust the possible variations, except for "isomeric" forms of the tables discussed, if a term may be borrowed from chemistry.

After the ground-work of this paper had been prepared, a detailed description of the Ungarinyin kinship system by A. P. Elkin (8) was received. The feature of

the kinship terminology of this tribe is that one term is applied to all members of one patrilineal clan in all generations. The term *wunini* is applied to father's sister's husband, sister's husband, and daughter's husband, that is, in three successive generations men of the *wunini* clan marry women of *ego's* clan. This means that the *wunini* relationship clan marry "mother's brother's daughter," tribally speaking. The term *maleni* is applied to father's sister's son, and sister's son, and such relatives must, therefore, be one clan with *wunini* in a patrilineal system. It is apparently not possible to draw up a genealogical table which will allow all exogamous units to marry "mother's brother's daughter," and "father's mother's brother's sister's daughter," but not "mother's mother's brother's daughter's daughter." A symmetrical table such as Table 1 will not apply. An asymmetrical pattern based on such type marriages as:—1. a1 marries B1, b1 marries A4; 2. a1 marries B3, b1 marries A4, in an eight-clan table, will satisfy these requirements to the extent that the kinship marriage type of Table 1 is preserved with the additional permission of "b" units to marry mother's brothers daughter. This type of table conforms to all Elkin's data, if *ego* be of "a" moiety and if *marini* be taken to be a personal term. The correspondence is too remarkable to be ignored. Spencer's data will not fit this table It had been thought that Table 1 might have been the true pattern of the Ungarinyin and Mangarai systems, and that the latter tribe afforded an example of a system intermediate between the Aranda class system and the Ungarinyin clan system without class organisation. In view of these latest facts, however, Table 1 is probably not the pattern of the Mangarai system. Table 2 is the probable solution of the problem, and it is to be expected that the kinship system of the Mangarai tribe will be found to be of the Aranda type.

This study has emphasised the value of the records of the marriages of "brother" and "sister" of one exogamous unit, and of genealogical data relating to the sequence of such exogamous units in the lines of direct female and male descent. It stands to reason that the intermarriage of a limited number of exogamous units in accordance with some definite rule for any considerable time must result in the appearance of a definite pattern both of genealogical relationships and kinship terminology. It is immaterial whether these units be classes or totemic clans for the appearance of these correlated patterns. Genealogical sequences, therefore, can be of the greatest value in determining the type of social organisation, in the detection of irregular marriages, and in the cross-checking of normal marriages This can be the case more especially in tribes reduced to a few members only, where it is impossible to obtain full genealogies.

A series of tables is appended to illustrate further correlations of genealogical pattern with kinship terminology. It will be noticed that the general symbols used in the present paper are different to those employed in a previous paper on the Aranda (6), as the former symbols are not appropriate to the greater complexity of the present tables. The former notations ′ and ″ have been replaced by numbers 1 and 2 respectively, and the former numbers differentiating named generations have been relegated to the commencement of each horizontal line representing a generation. These latter numbers are to be read as preceding the moiety letter of each symbol in that generation. For example, a1″ and b2′ of the previous paper are now represented as 1a2 and 2b1, respectively, the 1 of the a and the 2 of the b being placed to the left of their respective lines. The genealogical relationships can be traced without difficulty. Direct descent father to son is represented in vertical columns of the terms in small case letters, direct female descent in the vertical columns of the terms in capital letters. "Brother" and "sister," therefore, appear in each horizontal line as small and capital letters containing the same terms, *e.g.*, a2, A2. Descent is patrilineal, therefore, if two homologous terms such as a2 and A2 be identified in one horizontal line as "brother" and "sister," the "father" of these two will be represented in the a2

term immediately above "brother," and "mother" in the B term immediately above "sister." Similarly husband and wife can be identified by finding "brother" and "sister" from the son or daughter term in the generation below that of the individual in question considered as father or mother. The explanation to Tables 1 and 2, and the examples of Spencer's data given there, will make this clear.

The tables can be grouped conveniently in accordance with Radcliffe- Brown's norms of kinship and marriage, as follows:—

A. Systems, allowing marriage with "father's sister's daughter" and "mother's daughter," illustrated in Tables 3a and 3b. These have been presented before in the former symbolism, and are reproduced in order to show a series in conformable terms.

B. Systems, permitting marriages with "father's sister's daughter" but not with "mother's brother's daughter," illustrated in Tables 4a and 4b. No native systems of this type have been described, but the principle comes under discussion and the type marriages are of interest. In a six-clan table, of the 4b variety, 1b1 marries A3, in an eight-clan system 1b1 marries A4, and so on.

C. Systems, permitting marriage with "mother's brother's daughter" but not with "father's sister's daughter," illustrated in Tables 5a and 5b. This marriage rule has been described (4) as characteristic of the Karadjeri and Murngin tribes. Elkin (8) has recently given details of the kinship terminology of the former tribe, and these agree with the tables given here in identifying father's mother and mother's father in one clan. The type marriages are the same for systems of four, six and eight clans.

The alternative forms of Tables 4 and 5 have been given as examples of "isomeric" forms. These either represent "mirror images" of the genealogical patterns, or cause an inversion of A and B units in their order of sequence in descent. As there is no essential reason for one rather than another of the moities to be classed as "A" or "B," the genealogical pattern is not actually different in these variations, and the kinship pattern is identical as long as the system is a symmetrical one.

In systems B. and C., it will be noted that "sister exchange" marriages are not permitted. Also, that at least four clans are necessary to make these systems practicable.

D. Systems, permitting marriage with "father's mother's brother's son's daughter" and with "mother's mother's brother's daughter's daughter," but not with "father's sister's daughter" nor "mother's brother's daughter." This is the Aranda type, of which Table 6 is an illustration in the present symbolism. Variations of this type have been given for eight clan systems, with and without sister exchange, in the previous part of this paper. The type can also be represented in a six-clan system, with the same type marriages as those of Table 6, also with the type marriages:—1. a1 marries B1, b1 marries A2; 2. a1 marries B2, b1 marries A3.

If the units of all the four lines of the Aranda Table 6 be named independently, a sixteen-class system will be represented.

E. Systems, permitting marriage with "father's mother's brother's son's daughter" but not with "mother's mother's brother's daughter." This has been described as the type system of the Ungarinyin tribe (3).

Tables of this type can be subdivided into two varieties, *viz.*:—

(1) Those not permitting marriages of simpler type.
(2) Those in which such marriages are possible.

Of Systems E1, Table 1 is an illustration. Varieties of Table 1 can be prepared as mentioned before. Also, it will be found that if 2b2 in that table marry A1 instead of A3, the system will still be conserved and sister exchange permitted in each generation.

The same system can be expressed in tables of six inter-marrying clans, with type marriages such as:—1. a1 marries B1, b1 marries A1; 2. a1 marries B2, b1 marries A3. These type marriages are homologous with those of Table 1, and the kinship pattern is identical in both cases. It is not possible to represent the E1 kinship type with less than six inter-marrying clans. As stated before, Elkin's Ungarinyin terminology will not conform to these tables.

The E2 Systems can be expressed in tables of four clans, *e.g.*, with a type marriage of:—1. a1 marries B1, b1 marries A1; 2. a1 marries B2, b1 marries A1. In this case it will be found that the 1a units marry father's sister's daughter, the 1b units the mother's brother's daughter, while the 2b units marry both cross cousins.

With eight-clan tables it is possible to represent systems of the above type, and also systems in which clans of one moiety marry either mother's brother's or father's sister's daughter. A table of this type has been described on page 29. Elkin's data conform to this table but do not fill it. A table identical in kinship pattern with this last mentioned system can be expressed in a system of six clans. This is illustrated in Table 7, and has every appearance of actually representing the genealogical pattern of the relationship system of the Ungarinyin tribe, described by Elkin. An alternative formula is:—1. a1 marries B1, b1 marries A2; 2. a1 marries B2, b1 marries A2. The homology of the type marriages in these cases is clearly demonstrated. Converse marriages such as 1. a1 marries B3, b1 marries A1; 2. a1 marries B3, b1 marries A3, throw the irregular marriage into the "a" moiety.

F. Systems, permitting marriage with "mother's mother's brother's daughter's daughter" but not with "father's mother's brother's son's daughter." This type has not been described in the field. The forms of such a table were mentioned on page 28. This system can be expressed in tables of six clans based on type marriages such as 1. a1 marries B1, b1 marries A1; 2. a1 marries B3, b1 marries A2: 3. a1 marries B2, b1 marries A3. The homology in type of the marriages of this system is again apparent. At least six clans are required for the evolution of this system.

G. Systems, prohibiting marriage with either of the Aranda marriageable kin. This has been described as characteristic of the Yaralde (5) (Narrinyeri) tribe. One such table has been mentioned on page 28. Table 8 illustrates the system based on the same type marriages as in the previous case but allowing sister exchange in each generation. This system cannot be expressed exclusively in a table of less than eight clans (7). Six-clan tables can express the system but include marriages of simpler type as in the case of the E.2 Systems, but such tables cannot conform to Radcliffe-Brown's statement that women of the father's father's mother's clan are prohibited in marriage. Six-clan tables of this system have a cycle of three type marriages, and the repetition of these makes a marriage with a woman of the "father's father's mother's" clan a type marriage.

Radcliffe-Brown's kinship terminology of the Yaralde (9) does not fill an eight-clan table, and it conforms to an Aranda table just as well as to the more elaborate table. Radcliffe-Brown himself insists that the (5) Yaralde system is based on four lines of descent. It will be found that all the complex marriage rules given in his original paper are contained in the rule that a man marries according to the Aranda system, except that he does not marry a woman of his father's mother's family. Concerning marriages with the "mother's mother's brother's daughter's daughter," Radcliffe-Brown then stated: "I have no evidence that such marriages occurred, but there does not seem to be any objection to them as far as I understand the system." No new data have been given for the subsequent change of opinion. It seems certain, therefore, that no native "G system" has been described up to the present time.

The tables in this paper have been drawn up to illustrate the condition of patrilineal descent. They will apply equally well to the condition of matrilineal descent if the convention of the symbols be reversed so that small case letters represent females and capital letters represent males. In this case a table formerly illustrating a kinship marriage of "father's sister's daughter," or "mother's brother's daughter" will retain the same male-speaking kinship type, but a table formerly illustrating a kinship marriage of "father's mother's brother's son's daughter" will now express a male-speaking relationship of "mother's mother's brother's daughter's daughter," and vice versa.

In symmetrical tables the relationship "father's father's sister's son's daughter" will be found to be correlated with that of "father's mother's brother's son's daughter," and that of "mother's father's sister's daughter's daughter" with "mother's mother's brother's daughter's daughter." In asymmetrical tables of the E. 2. type these relationships may be dissociated.

These examples still further prove the intimate correlation of clan inter-marriage and genealogical pattern with kinship pattern and marriage rule. This appears to have an important bearing on the problem of the evolution of various tribal systems. That the natives of different localities rationally "reformed" their kinship terminology and their social organisation seems highly improbable. But in Australian tribes, clans are represented by numerous locally disposed family groups, members of which are represented in the algebraical terms of our tables, and type marriages. If local groups of a tribe with certain marriage rules found it inconvenient to comply with such rules, irregular marriages with local groups more conveniently disposed would arise. Such irregular marriages would tend to become customary, and custom would harden into tribal law, so making a new series of type marriages a tribal characteristic. The kinship pattern would conform as a natural consequence to the marriage system. Once a system had been established in this way, it could spread as a cultural feature.

This same mechanism may be responsible for the curiously mixed class names and class inter-marriages which appear in some tribes, where names obviously representing affinities with those of the Aranda system appear in a variety of combinations in inter-marriage and descent.

TABLE 1.

1.	a1	A1	b1	B1	a2	A2	b2	B2	a3	A3	b3	B3	a4	A4	b4	B4
2.	a1	B1	b1	A1	a2	B2	b2	A2	a3	B3	b3	A3	a4	B4	b4	A4
3.	a1	A2	b1	B4	a2	A1	b2	B3	a3	A4	b3	B2	a4	A3	b4	B1
4.	a1	B2	b1	A4	a2	B1	b2	A3	a3	B4	b3	A2	a4	B3	b4	A1
1.	a1	A1	b1	B1	a2	A2	b2	B2	a3	A3	b3	B3	a4	A4	b4	B4

Type Marriages:—1. and 3.: a1 marries B1, b1 marries A1; 2. and 4.: a1 marries B2, b1 marries A4. *Kinship of Marriage:*—A man marries his father's mother's brother's son's daughter, but not his mother's mother's brother's daughter's daughter. *Clan Descent:*—Great-grandparents of each male represe-sented in six clans; of father and son together in seven clans.

TABLE 2.

1.	a1	A1	b1	B1	a2	A2	b2	B2	a3	A3	b3	B3	a4	A4	b4	B4
2.	a1	B1	b1	A1	a2	B2	b2	A2	a3	B3	b3	A3	a4	B4	b4	A4
3.	a1	A4	b1	B4	a2	A1	b2	B1	a3	A2	b3	B2	a4	A3	b4	B3
4.	a1	B4	b1	A4	a2	B1	b2	A1	a3	B2	b3	A2	a4	B3	b4	A3
1.	a1	A3	b1	B3	a2	A4	b2	B4	a3	A1	b3	B1	a4	A2	b4	B2
2.	a1	B3	b1	A3	a2	B4	b2	A4	a3	B1	b3	A1	a4	B2	b4	A2
3.	a1	A2	b1	B2	a2	A3	b2	B3	a3	A4	b3	B4	a4	A1	b4	B1
4.	a1	B2	b1	A2	a2	B3	b2	A3	a3	B4	b3	A4	a4	B1	b4	A1
1.	a1	A1	b1	B1	a2	A2	b2	B2	a3	A3	b3	B3	a4	A4	b4	B4

Type Marriages:—1. and 3.: a1 marries B1, b1 marries A1; 2. and 4.: a1 marries B2, b1 marries A2. *Kinship of Marriage:*—Man marries father's mother's brother's son's daughter and mother's mother's brother's daughter's daughter. *Clan Descent:*—Great-grandparents, four clans 2, and 4.; six clans 1. and 3.

Key applying details of the Mangarai organisation to the general terms of Tables 1 and 2: a1, a2, a3, a4, b1, b2, b3, and b4 represent males of eight patrilineal clans. Females of the same clans are represented by capitals as: A1, A2, A3, etc., respectively. An "a" clan man always marries a "B" clan woman, and a "b" clan man an "A" clan woman. Horizontal lines indicate a generation, and the individuals of each clan are of different totems in each of four generations. These generations are indicated by a number at the left hand of each horizontal line, and this number is to be read as preceding each term of that line, so 1a1, 2a1, 3a1, 4a1 represent the individuals of one clan in four generations. The terms of the tables read as follows:—1a1, 1A1, Ngabullan and turkey; 1b1, 1B1, Ngangiella and goanna; 1a2, 1A2, 1a4, 1A4, Ngaritjbellan and wind; 1b2, 1B2, 1b4, 1B4, Ngaburella and kangaroo; 1a3, 1A3, Ngabullan and euro; 1b3, 1B3, Ngangiella and plain-wallaby; 2a1, 2A1, Ngapalieri and water-plant; 2b1, 2B1, Tjabijin and pelican; 2a2, 2A2, 2a4, 2A4, Ngapungari and cat-fish; 2b2, 2B2, Nakomara and paddy-melon; 2a3, 2A3, Ngapalieri and brush-tailed wallaby; 2b3, 2B3, Tjabijin and opossum; 2b4, 2B4, Nakomara and snake; 3a1, 3A1, Ngabullan and poison-snake; 3b1, 3B1, Ngangiella and black-snake; 3a2, 3A2, 3a4, 3A4, Ngaritjbellan and frilled lizard; 3b2, 3B2, 3b4, 3B4, Ngaburella and porcupine; 3a3, 3A3, Ngabullan and sugar-bag; 3b3, 3B3, Ngangiella and crocodile; 4a1, 4A1, Ngapalieri and bat; 4b1, 4B1, Tjabijin and lily; 4a2, 4A2, 4a4, 4A4, Ngapungari and native-companion; 4b2, 4B2, Nakomara and small-hawk; 4a3, 4A3, Ngapalieri and rain; 4b3, 4B3, Tjabijin and dingo; 4b4, 4B4, Nakomara and rock-wallaby.

Spencer's data of marriage and descent apply to the table as follows:—

Ngangiella and goanna, 1b1, marries Ngabullan and turkey, 1A1; children are Tjabijin and lily (amended to Tjabijin and pelican, 2b1, 2B1, *vide* text).

Ngaburella and kangaroo, 1b2, marries Ngaritjbellan and wind, 1A2; children are Nakomara and paddy-melon, 2b2, 2B2.

Ngangiella and plain-wallaby, 1b3, marries Ngabullan and euro, 1A3; children are Tjabijin and opossum, 2b3, 2B3.

Ngapalieri and water-plant, 2a1, marries Nakomara and paddy-melon, 2B2; children are Ngabullan and poison-snake, 3a1, 3A1.

Nakomara and paddy-melon, 2b2, marries Ngapalieri and brush-tailed-wallaby, 2A3; children are Ngaburella and porcupine, 3b2, 3B2.

Tjabijin and pelican, 2b1, marries Ngapungari and cat-fish, 2A4 in Table 1, 2A2 in Table 2; children are Ngangiella and black-snake, 3b1, 3B1.

Ngaburella and porcupine, 3b2, marries Ngaritjbellan and frilled-lizard, 3A2; children are Nakomara and small-hawk, 4b2, 4B2.

Ngabullan and sugar-bag, 3a3, marries Ngangiella and crocodile, 3B3; children are Ngapalieri and rain, 4a3, 4A3.

Ngapalieri and rain, 4a3, marries Nakomara and rock-wallaby, 4B4; children are Ngabullan and euro, 1a3, 1A3.

Tjabijin and dingo, 4b3, marries Ngapungari and native-companion, in Table 1, 4A2, in Table 2, 4A4; children are Ngangiella and plain-wallaby, 1b3, 1B3.

TABLE 2.A.

1. a1 A1 b1 B1
1. a1 B1 b1 A1
1. a1 A1 b1 B1

Dual System.

TABLE 3.B.

1. a1 A1 b1 B1
2. a1 B1 b1 A1
1. a1 A1 b1 B1

Four-class System.

Type Marriages of Dual and Four-class Systems:—a1 marries B1, and b1 marries A1. *Kinship of Marriage:*—Man marries father's sister's daughter, or/and mother's brother's daughter. *Clan Descent:*—Mother's and father's clans only.

TABLE 4.A.

1. a1 A1 b1 B1 a2 A2 b2 B2
2. a1 B1 b1 A2 a2 B2 b2 A1
1. a1 A1 b1 B1 a2 A2 b2 B2

Type Marriages:—1.: a1 marries B2, b1 marries A1; 2.: a1 marries B1, b1 marries A2.

TABLE 4.B.

1. a1 A1 b1 B1 a2 A2 b2 B2
2. a1 B2 b1 A1 a2 B1 b2 A2
1. a1 A1 b1 B1 a2 A2 b2 B2

Type Marriages:—1.: a1 marries B1, b1 marries A2; 2.: a1 marries B2, b1 marries A1.

Kinship of Marriage:—Man marries father's sister's daughter, not mother's brother's daughter. *Clan Descent:*—Grandparents belong to three clans, father's father and mother's mother being in one clan.

TABLE 5.A.

1. a1 A1 b1 B1 a2 A2 b2 B2
2. a1 B1 b1 A2 a2 B2 b2 A1
1. a1 A2 b1 B2 a2 A1 b2 B1
2. a1 B2 b1 A1 a2 B1 b2 A2
1. a1 A1 b1 B1 a2 A2 b2 B2

Type Marriages:—a1 marries B2, b1 marries A1.

TABLE 5.B.

1. a1 A1 b1 B1 a2 A2 b2 B2
2. a1 B2 b1 A1 a2 B1 b2 A2
1. a1 A2 b1 B2 a2 A1 b2 B1
2. a1 B1 b1 A2 a2 B2 b2 A1
1. a1 A1 b1 B1 a2 A2 b2 B2

Type Marriages:—a1 marries B1, b1 marries A2.

Kinship of Marriage:—Man marries mother's brother's daughter, not father's sister's daughter. *Clan Descent:*—Grandparents belong to three clans, father's mother and mother's father being in one clan.

TABLE 6.

1. a1 A1 b1 B1 a2 A2 b2 B2
2. a1 B1 b1 A1 a2 B2 b2 A2
3. or 1. a1 A2 b1 B2 a2 A1 b2 B1
4. or 2. a1 B2 b1 A2 a2 B1 b2 A1
1. a1 A1 b1 B1 a2 A2 b2 B2

Type Marriages, Aranda System:—1. (and 3.): a1 marries B1, b1 marries A1; 2. (and 4.): a1 marries B2, b1 marries A2. *Kinship of Marriage:*—Man marries neither father's sister's daughter nor mother's brother's daughter, but marries father's mother's brother's son's daughter and mother's mother's brother's daughter's daughter. *Clan Descent:*—Four Grand-parents in four individual clans.

TABLE 7.

1. a1 A1 b1 B1 a2 A2 b2 B2 a3 A3 b3 B3
2. a1 B2 b1 A1 a2 B3 b2 A2 a3 B1 b3 A3
1. a1 A3 b1 B2 a2 A1 b2 B3 a3 A2 b3 B1
2. a1 B1 b1 A2 a2 B2 b2 A3 a3 B3 b3 A1
1. a1 A2 b1 B3 a2 A3 b2 B1 a3 A1 b3 B2
2. a1 B3 b1 A3 a2 B1 b2 A1 a3 B2 b3 A2
1. a1 A1 b1 B1 a2 A2 b2 B2 a3 A3 b3 B3

Type Marriages:—1.: a1 marries B1, b1 marries A3; 2: a1 marries B3, b1 marries A3. *Kinship of Marriage:*—Man marries father's mother's brother's son's daughter, not mother's mother's brother's daughter's daughter, but "b" clan men also marry mother's brother's daughter. Also, no clan can marry father's father's sister's son's daughter, and "b" clan men cannot marry mother's father's sister's daughter's daughter. *Clan Descent:*—Grandparents represent four separate clans to "a," three clans to "b" individuals; great-grandparents in five clans.

TABLE 8.

1.	a1	A1	b1	B1	a2	A2	b2	B2	a3	A3	b3	B3	a4	A4	b4	B4
2.	a1	B1	b1	A1	a2	B2	b2	A2	a3	B3	b3	A3	a4	B4	b4	A4
3.	a1	A2	b1	B2	a2	A1	b2	B1	a3	A4	b3	B4	a4	A3	b4	B3
4.	a1	B4	b1	A4	a2	B3	b2	A3	a3	B2	b3	A2	a4	B1	b4	A1
1.	a1	A1	b1	B1	a2	A2	b2	B2	a3	A3	b3	B3	a4	A4	b4	B4

Type Marriages:—1.: a1 marries B1; b1 marries A1; 2.: a1 marries B2, b1 marries A2; 3.: a1 marries B3, b1 marries A3; 4.: a1 marries B4, b1 marries A4. *Kinship of Marriage:*—Man marries neither of Aranda type of kinships, but marries clan of mother's mother's mother. *Clan Descent:*—Eight Great-grandparents belong to eight individual clans.

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ADELAIDE UNIVERSITY FIELD ANTHROPOLOGY, CENTRAL AUSTRALIA.

No. 12—BOTANICAL NOTES OF ANTHROPOLOGICAL INTEREST, FROM MACDONALD DOWNS, CENTRAL AUSTRALIA.

By J. Burton Cleland, M.D.

[Read July 14, 1932.]

In August, 1930, the Board of Anthropological Research of the University of Adelaide, together with the South Australian Museum, organised an expedition to Mr. Chalmers' property at Macdonald Downs, about 150 miles north-east of Alice Springs. The expedition was financed to a great extent by the Rockefeller Foundation through the Australian National Research Council. The intimate acquaintance with the native language of the two daughters and two sons of Mr. and Mrs. Chalmers enabled much valuable information to be obtained as regards the use made by the natives of various plants.

It is proposed to collect in future expeditions as much information as possible on the botanical side of the ecology of the Australian native. An effort will be made to ascertain how far the aborigine is dependent on the vegetation for his existence, and how, perhaps, in the course of time he may have modified his surroundings. It is also intended to show how European invasion of the territory of the blacks has altered the flora, and so interfered with the native's prospects of existence. It is proposed to ascertain the various ways in which vegetable productions are utilized, and to obtain as complete a vocabulary of their native names as possible. The present paper may be looked upon as the first of such a series.

Marsiliaceae.—Nardoo *(Marsilea)* grows in the creek beds and in similar situations where water lodges for some time. A smooth-leaved species has no native name, the sporocarps not being used for food.

Grasses.—The native women were found returning with coolamons partly full of grass seeds. An opportunity was taken later of seeing the method of collection. An extensive plain extended south-west from the station, and parts of this had evidently been heavily grassed during the good season following the summer rains. Only dried stalks now, however, remained at the time of our visit. A small species of ant had laboriously collected considerable quantities of grass seed grains in their husks and stored them around the openings into their nests. These seeds the women scraped up in handfuls into their coolamons. When a sufficient quantity had been gathered together, a hole was dug in the sandy loam about 1 foot deep near the base of a small mulga. Into it the grain was emptied, and then one of the women stepped into the hole and worked her feet around amongst the grain and soil, meanwhile supporting herself by means of her hands against the trunk of the mulga, thus enabling more vigorous foot-work to be undertaken. Eventually most of the grain was in this way husked by the combined movements of the feet and the friction of particles of soil. It was then winnowed by being dexterously rocked in various directions at varying angles and at different speeds in a coolamon. By this means the chaff was separated by one

set of movements, little stones and dirt by another, and finally a product was obtained almost completely clean and free from extraneous matter. These movements of "yandying" the grain have been utilized in North-west Australia for the separation of particles of tin from other pebbles. The grain was then ground between two stones with a little added water, and made into a paste and cooked.

Samples of the grain were brought back under two separate names, one being *"ngilyara,"* and the other *"otetta."* These two grains looked remarkably alike. Seeds were given to Mr. J. F. Bailey, of the Botanical Gardens, Adelaide, and grasses raised. *Pannicum distachyum* grew from *"ngilyara,"* and *Dactyloctenium radulans* from *"otetta."* It does not seem certain, however, that these two names apply, respectively, to the two grasses mentioned. There may have been some intermixture of seeds in the field. From another source the grass *D. radulans* was given the native names of "Wudalgwia" and "Unkwala."

Eulalia (Pollinia) fulva, native name *"albilba,"* seed not eaten.

Themeda australis (triandra), no name, seed not eaten.

Setaria Dielsii, growing on the creek bank, no name, seed not eaten.

Spinifex paradoxus, "punga," not used. This grass grows on sandy rises. Sometimes the female plants grow in a community together, the males in a separate but contiguous patch. The natives recognise the female plants as *"kwia," i.e.*, females.

Aristida Browniana, "ilgilgyera."

Triodia, sp. The resinous material covering the bases of the stems is collected and used as a fastening for the knob on spear-throwers, etc.

A tall *Chloris,* growing by the creek bank, had no name, the seed not being used.

Astrebla pectinata, Mitchell grass, *"araila."*

PROTEACEAE.—*Hakea lorea,* Corkwood, *"un'gia."*

Grevillea striata, Beefwood, *"ildinja."*

SANTALACEAE.—*Santalum lanceolatum, "alkwa."*

LORANTHACEAE.—*Loranthus, "amara"* (followed by the native name of the host plant). They eat the fruit of the species, probably *L. Exocarpi,* occurring on mulga *(Acacia aneura)* and on a *Cassia* growing on stony ridges, but not those of the species growing on Gidyea *(Acacia Cambagei),* and on Beefwood *(Grevillea striata). L. Quandang* was found on Gidyea near Macdonald Downs. *L. gibberulus* grows on the Beefwood.

CAPPARIDACEAE.—

Capparis Mitchelli, "trogea," fruits eaten.

Capparis, sp. (a small tree), *"ung'durika."* (Fruit round, like a green orange, taste a bit bitter, reddish seeds. When unripe, juice tastes of horse-radish).

Capparis, sp. (shrubby, climbing), *"aldura."* (Fruit oval, splits when ripe. The best bush fruit. Blue seeds, yellow pulp, taste somewhat like passion fruit.) Fruit buried till ripe on account of birds. On the flowers, both these species of *Capparis* were identified at the Botanic Gardens, Sydney, as *C. lasiantha.*

PITTOSPORACEAE.—*Pittosporum phillyreoides, "wuldera," "a'woldera."*

LEGUMINOSAE.—*Acacia estrophiolata,* Ironwood, *"atimba"* or *"attanga."*

A. Cambagei, Gidyea, *"udnanta."*

A. aneura, Mulga, *"etitja."*

Cassia (two broad phyllodes), *"aterika."*

C. eremophila, "abwunna," seeds not eaten.

Glycine, sp. No name.

Vigna lanceolata, "alaitya." This pea has a long tap root of 14 to 16 inches, with a swollen part, sometimes moniliform, for about a foot. The native women recognise the withered remains of the plant and dig down in the sandy loam of the creek bank, jabbing with a yam-stick in one hand and scraping out the loosened soil alternately with the other, in search of these little "yams," as they are called by the white settlers.

SAPINDACEAE.—*Atalaya hemiglauca, "adngatta."*

RHAMNACEAE.—*Ventilago viminalis,* Supple-jack, *"an'ngerra."*

MYRTACEAE.—*Eucalyptus rostrata* (red gum), *"aberra."*

E. pyrophora (or *terminalis)* (bloodwood), *"irakara."*

E. papuana (cabbage gum), *"willamba."*

E. microtheca (coolabah), *"enderra."*

ASCLEPIADACEAE.—*Marsdenia australis.* The young pods are eaten, and also the young shoot of the seedling.

CONVOLVULACEAE.—Small convolvulus, probably *Convolvulus erubescens, "anadawatup."* Not eaten.

SOLANACEAE.—

Solanum chenopodinum, small, with red berries, growing on the river banks; no name; not eaten.

Solanum ellipticum, prickly stems, pale green berries, *"albaranji";* fruits eaten.

Nicotiana suaveolens, "underilpa"; not used as a narcotic.

N. excelsior (presumably), larger leaves, less hairy, *"ung'wulpa."* The leaves are chewed and used as "pituri." The first time the leaf is chewed the head and ground seem to go round; they vomit but do not sweat; it is not accompanied by diarrhœa. Mixing with ashes makes the action stronger. If a native feels he would like to vomit, a little of this "pituri" will cure the condition. They will not take the leaf from neighbouring blacks until it has been tested, in case it may have been "sung." To ascertain whether this has been the case it is buried in the ground. If it has disappeared by next day, then they know that it had been "sung."

SCROPHULARIACEAE.—*Stemodia viscosa, "ing'dang'ing."*

MYOPORACEAE.—*Eremophila,* sp., *"ud'naranga."*

RUBIACEAE.—*Coelospermum reticulatum, "arakea."*

CAMPANULACEAE.—*Wahlenbergia gracilis, "juija";* not eaten. They have no name for the bright blue colour of the flower, but say it is not black. Miss Jess Chalmers was wearing a sky-blue dress as we questioned my woman informant, with the blue Native Hair-bell on the bank beside us. The sky-blue dress was said to be nearly like the colour of the black socks I was wearing. A dark blue is called black.

COMPOSITAE.—A *Centipeda* with an unpleasant aromatic smell, as well as a *Brachycome* (or *Minuria),* both seemed to have the same name, *"albidabita."* Neither were used.

Gnaphalium luteo-album, "nga'dingida"; not used.

Pterocaulon sphacelatum. Apparently was called by the same name.

ADDITIONS TO THE FLORA OF SOUTH AUSTRALIA.

No. 30.

By J. M. Black, A.L.S.

Read July 14, 1932.

Plates I. and II.

Gramineae.

Danthonia geniculata, J. M. Black. Specimens cultivated from selected seed at the Waite Agricultural Research Institute have the panicle 2½ to 5 cm. long and sometimes containing as many as 40 spikelets.

Cyperaceae.

When *Lepidosperma concavum*, R. Br. has a panicle longer and somewhat looser than usual, it can be distinguished from *L. laterale*, R. Br. not only by the crowded spikelets, but also (at least in South Australian specimens) by the hypogynous scales, which are short and broad (⅓ to ½ the length of the nut), not ciliate, but minutely penicillate at summit, while *L. laterale* has the scales tipped by a ciliate awn or bristle, which makes them as long, or nearly as long, as the nut.

Liliaceae.

Bulbine semibarbata (R. Br.) Haw. n. var. *depilata*. Variat filamentis subaequalibus imberbibus vel circum medium pilis minutis tantum sub lente visibilibus barbatis. (Tab. I., fig. 1.)

Near Marree, July, 1931; coll. D. N. George. Only a single specimen was received by the Waite Agricultural Research Institute. The almost beardless filaments of the stamens suggest the genus *Bulbinella*, but under the microscope a ring of minute hairs is visible near the middle of at least some of the filaments. The basal sheaths of the leaves are broader and widen more abruptly below the blades than is usual in *B. semibarbata*, with which the variety agrees in the size of the flowers and in the fibrous roots. Ripe fruits might indicate some difference entitling this plant to specific rank, but only flowers were present, and their colour was not discernible.

Bulbinella is defined as having glabrous filaments and 2 collateral ovules in each cell of the ovary, while *Bulbine* has bearded filaments and "several ovules in each cell superposed in 2 rows." The latter distinction does not appear to hold good in at least one of the two Australian species, for in all the ovaries which I examined, both of the type of *B. semibarbata* and of the variety here described, there were only 2 ovules in each cell, or 6 in the whole ovary.

**Allium vineale*, L., Crow Garlic. Reported by Worsley C. Johnston as growing on about 300 acres at Kangaroo Flat and Wasleys. This weed often bears only a dense head of bulbils, without any flowers—Europe; introduced in U.S.A.

**Allium paniculatum*, L. Occupying a considerable area of agricultural land near Tarlee. Unlike the preceding it has no odour of onion.—Mediterranean region.

**Asparagus officinalis*, L. The garden asparagus gone wild.—Upper Middleton Creek and valley behind Port Elliot; near channels of irrigation settlements on the Murray.—Mediterranean region.

Santalaceae.

Professor J. B. Cleland returned from Central Australia with specimens of *Santalum lanceolatum*, R. Br. which he found to be locally a shrub about 2 m. high, with spreading branches and rather thick, rigid, broad leaves. This typical form, found chiefly in Northern Australia, has the leaves 4-8 cm. long, 1-3 cm. broad, usually acute, but sometimes a few are obtuse. The var *angustifolium*, Benth, apparently the only form found in South Australia, is a tree 4 to 8 m. high, usually with drooping branches and resembling *Pittosporum phillyreoides*. The leaves are linear-lanceolate, thinner, 3-7 cm. long, 5-10 mm. broad, always acute. Mr. C. J. White, Government Botanist of Queensland, was consulted, and writes that the species is extremely variable in that State, always a tree in the normal form, the branches often somewhat drooping. That there is variation in size is clear from the fact that Brown described his *S. lanceolatum* as a shrub and his *S. venosum* (which only differs in having the nerves of the leaves more distinct) as a tree. All his specimens were collected on the "islands of the Gulf of Carpentaria." There is no difference between the flowers and fruits of the type and those of var. *angustifolium*. It is worthy of note that in some of our most northerly specimens of var. *angustifolium* (Oodnadatta, Dalhousie, Minnie Downs, Diamantina River), the leaves tend to become thicker and stiffer, although not exceeding 10 mm. in breadth, and thus show a tendency towards the narrower leaves sometimes found on the type. The places where Professor Cleland made his collection were mostly just within the tropic, near the Bundey and Fraser Rivers and Mount Ultim; others from further south, at Hermannsburg.

Aizoaceae.

Carpobrotus Pulleinei, n. sp. Herba perennis, carnosa, caulibus prostratis, radicantibus; folia opposita, lineari-lanceolata, trigona, subtiliter granulata, 6-10 cm. longa, in tribus lateribus 5-9 mm. lata; flores parvi, subsessiles, terminales, saepius trini; perianthii lobi 6, duo exteriores foliacei, trigoni, accrescentes, quatuor interiores virides, 5-6 mm. longi, eorum duo lanceolati, ceteri duo ovati, scarioso-marginati; stamina petaloidea circ. 30, rubra, linearia, 7 mm. longa; stamina circ. 20, brevissima, filamentis basi pilosulis; stigmata 4; ovarium 4-loculare, placentis parietalibus; fructus oblique ventricosus, succulentus, 1 cm. longus, breviter pedunculatus, indehiscens; semina numerosa, rubella, ovata, 1 mm. longa. (Tab. I., fig. 3.)

Nonning (Gawler Ranges), coll. R. H. Pulleine; Pine Creek, near Broken Hill, New South Wales, coll.. A. Morris.

Since 1921 Mr. N. E. Brown has been engaged on a revision of the old genus *Mesembryanthemum*, published at irregular intervals in the Gardeners' Chronicle. As a result some 70 or 80 new genera have been established or revived, *Mesembryanthemum* proper now consisting of comparatively few species. The new division is based on the characters of the fruit, the placentation of the ovules, position of the leaves, etc. *Carpobrotus*, N. E. Br. is distinguished from the other genera by the juicy indehiscent fruit, which does not open by valves at the summit. The new Australian species is named after the collector, Dr. R. H. Pulleine, who takes a keen interest in the tribe *Mesembryanthemeae*, and has cultivated many of the curious South African species at his home in Mitcham.

This species, which flowers at the beginning of summer, is distinguished from *C. aequilateralis* by its minutely granular leaves, its small red flowers, usually in 3's, its 4 stigmas and 4 cells of the ovary, an unusually small number for the genus.

Carpobrotus aequilateralis (Haw.) n. comb.—*Mesembryanthemum aequilaterale*, Haw.

Disphyma australe (Soland.) n. comb.—*Mesembryanthemum australe*, Soland. (Plate I., fig. 4.) Unfortunately Mr. Brown has not completed his new classifica-

tion, nor apparently turned his attention to our Australian species, but there seems little doubt that this plant—our "Round-leafed Pigface"—belongs to the genus *Disphyma*, whose fruit, when expanded after moistening in water, opens by 5 valves, which turn backwards and spread horizontally, exposing the capsule. The 5 cells are roofed with membranous wings, which cover the seeds and partially conceal the small 2-lobed tubercles, resembling twin tubercles, which stand at the entrance to each cell and alternate with the valves.

Of our introduced species *M. crystallinum*, L. (the Ice Plant) is *Cryophytum crystallinum* (L.) N. E. Br.; *M. caducum* Ait. is *Cryophytum caducum* (Ait.) L. Bolus; *M. floribundum*, Haw. remains in the genus *Mesembryanthemum; M. edule*, L. becomes *Carpobrotus edulis* (L.) N. E. Br.; *M. angulatum*, Thunb. is *Cryophytum Aitonis* (Jacq.) N. E. Br.

PORTULACACEAE.

Calandrinia remota, J. M. Black, descr. emend. Herba perennis carnosa, glabra, caulibus brevibus, crassis, ascendentibus; folia verticillata vel rarius alterna, cylindrata, laevia, 1-5 cm. longa, 3-6 mm. diam., erectopatentia, in mucronem parvum incurvum caducum desinentia; pedunculi graciles, 4-30 cm. longi, laxe racemosi, 8-18-flori vel, in locis peraridis 1-6-flori, deorsum nudi vel basin versus 1-2 foliis instructi, imâ basi incrassati; pedicelli 15-20 mm. longi, fructiferi patentes vel reflexi, ad basin parvâ bracteâ suffulti; sepala cymbiformia, viridia, 4 mm. longa; petala 5, obovata, purpurascentia, 12 mm. longa, in calyptram marcescentia; stamina 60-90, biserialia, filamentis 4 mm. longis, prope basin ciliatis, antheris pallide purpureis, ¾ mm. longis; stigmata 3, usque ad ovarium libera; capsula ovoidea 3-valvi sepala paulum superans; semina numerosa, reniformia, ¾ mm. diam., fusco-rubra usque pallentia, nitida, concentrice punctulata usque fere laevia. (Tab. II., fig. 2.)

Mount Gunson; Wynbring; Tarcoola; Ooldea; Lake Callabonna; Strzelecki and Cooper Creeks. Also in Central Australia and Victoria Desert, Western Australia.

This plant, with its smooth, fleshy, exactly cylindrical leaves is probably our commonest parakeelya, but it has hitherto been chiefly known, I think erroneously, as *C. polyandra*. *C. polyandra* (Hook.) Benth. was grown in England from seeds sent by Drummond in 1853 from "Swan River Settlement." It was originally described in the Botanical Magazine, t. 4833 (1855), by Sir Wm. Hooker as *Talinum polyandrum*, with "leaves alternate or very rarely opposite, fleshy, obtuse, having a depressed longitudinal central line above, flat below; anthers yellow." The accompanying figure in the Botanical Magazine shows leaves answering the description and closely resembling those of *C. balonnensis*, Lindl. (see my plate II., fig. 1). The leaves of *C. polyandra* are said to be narrower; both species have yellow anthers, while *C. remota* has purplish ones; in fact, the chief distinction between *C. balonnensis* and *C. polyandra* (which latter is perhaps confined to Western Australia) seems to be that the former has the 3 linear stigmas rising from a short but distinct style, while *C. polyandra* (like *C. remota)* has them sessile on the ovary.

C. remota was first described by me in these Trans. 42 : 369 (1923) from small dried specimens collected near Mount Gunson and Tarcoola. I have recently been able to grow this species and *C. balonnensis* from plants brought from Central Australia by Professor J. B. Cleland. *C. remota* varies much in size. Some dwarf specimens in the Tate Herbarium, collected by Helms in the Victoria Desert, have all the leaves in a basal rosette, and very few flowers in the raceme, sometimes only a terminal one. The seeds vary in colour from dark-red to amber, and the pitting may be quite distinct or so faint that it can only be seen under the microscope as

a delicate reticulation. It is possible that the plant is sometimes annual, especially in very dry country.

C. polyandra (Hook.) Benth. var. *leptophylla*, Benth., quoted for the "W. coast" of Western Australia, is perhaps the same as *C. remota*.

LEGUMINOSAE.

Acacia barattensis, nov. sp. Frutex glaber, ramulis viscosissimis vix angulatis; phyllodia angusto-linearia, rigidula, subfalcata, papilloso-viscida, utroque latere bi-trinervia, 5-7 cm. longa, 1 mm. lata, apice uncinata, prope basin parvâ glandulâ instructa; pedunculi axillares, solitarii vel gemini, viscidi, 5-8 mm. longi; capitula globosa, circ. 12-flora; calyx glaber, breviter obtuseque 4-lobus, ¾ mm. longus; petala 4, glabra, 2 mm. longa, saltem circa medium cohaerentia; ovarium glabrum, breviter stipitatum; legumen ignotum. (Tab. I., fig. 2.)

Near Baratta head-station, on a branch of the Siccus River and 20 miles west of Koonamore.

Belongs to Bentham's series VII., *Plurinerves*, section D, *Oligoneurae*. Near *A. subporosa*, F. v. M., but that is a tree inhabiting wet country in the eastern parts of New South Wales and Victoria, with phyllodes 2-8 mm. broad, viscid only when young and marked with semi-transparent dots which are absent in our species; the flowers in each head are more numerous (20 to 30) and usually 5-partite, while in *A. barattensis* the sepals and petals are always 4. Our plant is a shrub, intensely viscid on the branches and on the long, hooked, very narrow phyllodes (1 mm. broad), with a small gland close to the base. Probably the pod, when known, will show further differences.

Acacia rhetinodes, Schlechtd. n. var. *uncifolia*. Variat phyllodiis minoribus (3-4 cm. longis, circ. 5 mm. latis) valde recurvo-mucronatis.

Waitpinga Road, near Encounter Bay; growing in sand and limestone, away from water. Flowering and fruiting in January, 1932; coll. J. B. Cleland. The small phyllodes, terminating in a curved, almost hooked mucro, give this variety a very different appearance from the type, which is usually found in gullies or near creeks. The flowers and pods are the same in both.

**Lotus angustissimus*, L. This annual has appeared on land which had been drained and top-dressed with superphosphate near Lucindale, S.E. It now covers many hundreds of acres in the district and provides good fodder.—Western Europe and Mediterranean region.

EUPHORBIACEAE.

Euphorbia Murrayana, nov. sp. Parva planta perennis, 10-20 cm. alta; caulis erectus, rigidus, dichotome ramosus, fere glaber, 5-9 mm. diametro; folia lineari-oblonga, glabra, truncatula, acute dentata, in petiolum brevem ad basin incrassatum angustata, 1-3 cm. longa, 3-6 mm. lata, inferiora alterna, in ramis floriferis opposita vel quasi opposita, omnia plus minusve caduca; stipulis nullis; cyathia solitaria, singula in unâ de axillis oppositis, breviter pedunculata, 2 mm. longa, pedunculo prope basin articulato, glandulis 4 vel 5, rubris, latis, exappendiculatis; capsula 4 mm. longa, glabra, laevis; semina ovoidea, sublaevia, albida, circ. 3 mm. longa, ecarunculata. (Tab. I., fig. 5.)

Wooltana Station (between Flinders Range and Lake Frome), *S. A. White;* Murnpeowie Station (E. of Marree), *H. W. Andrew;* South Gap, near S.W. end of Lake Torrens, *Miss B. J. Murray;* Parachilna (E. of Lake Torrens), in Tate herbarium.

This plant seems to have been hitherto included in *E. eremophila*, A. Cunn., from which it differs in its shorter, stouter and more rigid stems and branches, in the leaves with longer and almost horizontal teeth, and chiefly in the whitish,

smooth, ovoid seed, without any caruncle. *E. eremophila* has an oblong, brownish, granular-rugulose seed, with a conspicuous caruncle and its leaves are entire or have short oblique teeth. The new species is called after Miss B. Jean Murray, B.Sc., who brought specimens from Lake Torrens and succeeded in growing several plants in Adelaide. Locally it is known as "Leafless Milk Bush," from the early falling of the leaves. *E. deserticola,* F. v. M., from the western side of the Flinders Range, near Kanyaka and Arkaba, is evidently, from the description of the seed, the same as *E. eremophila,* with which it was united by Bentham.

FRANKENIACEAE.

Frankenia crispa, n. sp. Planta ut videtur perennis; rami pilis brevibus crebris clavatis recurvatis incani; folia 4-8 ad nodos glomerata, breviter petiolata, linearia, 2-5 mm. longa, vix 1 mm. lata, margine recurva, supra glabrescentia, subtus puberula; internodia 5-15 mm. longa; folia floralia (bracteae) caulinis similia, petiolis vaginisque ciliolatis; flores in densas cymas dispositi; calyx cylindratus, 6-7 mm. longus, 1½ mm. diam., 5-dentatus, pilis brevibus recurvis obsitus; petala 5, purpurascentia, 8-10 mm. longa, laminis circ. 3 mm. latis; stamina saepius 6, filamentis medio dilatatis, antheris purpureis, ¾-1 mm. longis; styli rami 3, 1½-2 mm. longi, pars integra 5-6 mm. longa; ovarii placentae 3, parietales; ovula 3, pendula, singula supra medium cujusque placentae affixa; capsula conica, 3½-4 mm. longa, semine saepius unico, conico-oblongo, glabro, laevi, 2½ mm. longo (Tab. II., fig. 4.)

On the Curnamona-Willippa track, about 8 miles E. of Willippa, Flinders Range; coll. J. B. Cleland, December 1, 1930.

Differs from *F. densa,* Summerh. in the longer calyx not dilated towards summit and the 3 ovules attached above the middle of the placentas instead of near the base; also in the greener leaves, glabrous seed and in the calyx and branches covered with conspicuous clavate downward-curved hairs, instead of a minute pubescence of spreading hairs.

Frankenia orthotricha, n. sp. Planta annua, 7-10 cm. alta, caulibus ascendentibus ramisque breviter patenti-pilosis; folia petiolata, tenuia, omnino vel fere glabra, caulina obovata, 3-5 mm. longa, 2-2½ mm. lata, subplana vel margine leviter recurva, floralia (bracteae) oblongo-lanceolata, margine recurva, petiolo 1-2 mm. longo; internodia 7-17 mm. longa; calyx in medio subturgidus, 5-6 mm. longus, pilis minutis rectis obsitus, costis 5, prominentibus; petala 5, purpurea, 10 mm. longa, laminis 4-5 mm. latis; stamina 6-8, antheris 1¼ mm. longis; styli rami 3, 2-2½ mm. longi, pars integra 3-3½ mm. longa, stigmatibus clavatis; ovarii placentae 3, parietales; ovula 35-40 (12-14 pro placentâ); semina fusiformia, reticulata, circ. ¾ mm. longa. (Tab. II., fig. 5.)

Diamantina River, S.A.; coll. L. Reese, May, 1931.

This species is near the Queensland plant described by Summerhayes as *F. annua,* and was very shortly described by me as *F. annua* var. *orthotricha* in these Transactions, vol. 55:140 (1931). On more mature consideration it seems to me that it should be treated as a distinct species on account of the minute straight (not hooked) hairs which cover the stems, branches and calyx, the calyx not quite cylindrical but swollen about the middle to a diameter of 2½ mm., with 5 very prominent ribs, the lamina of the petals broader and the ovules more numerous. Also resembles *F. pulverulenta,* but the stems are stouter, more erect, and the leaves, calyx and petals different.

The meritorious revision of all the then known Australian *Frankenias* by V. S. Summerhayes, B.Sc., in Journ. Linn. Soc. 48:337-388 (1930) renders it advisable to subjoin a short key to all the known South Australian species. The genus is a difficult one because of the external similarity of a considerable number of the species.

SECTION I. *Toichogonia.* Placentas parietal, 3, rarely 2.

A. Leaves shortly petiolate.
  B. Ovules 1-2 to each placenta; leaves linear or lanceolate, 2-5 mm. long, 1 mm. broad or less, with revolute margins.
    C. Calyx 4-5 mm. long, dilated towards summit, with minute straight hairs; placentas 2-3; funicles long, attached near base of placenta, seed pubescent; leaves pubescent above *F. densa* 1
    C. Calyx 6-7 mm. long, cylindrical, with recurved hairs; branches hoary with recurved hairs; placentas 3; funicles short, attached above middle of placenta; seed glabrous; leaves glabrous above .. .. *F. crispa* 2
  B. Ovules 3-15 to each placenta.
    D. Annuals; leaves obovate or oblong, almost glabrous above.
      E. All leaves flat; calyx 4 mm. long, glabrous; petals 4 mm. long; ovules 8-15 to each placenta, stems prostrate .. *F. pulverulenta* 3
      E. Upper leaves with recurved margins; calyx 6 mm. long, pubescent; petals 8-10 mm. long; ovules 12-14 to each placenta; stems ascending .. .. *F. orthotricha* 4
    D. Perennials.
      F. Sheath of floral leaves tubular; leaves broad-lanceolate, hairy above; calyx 5 mm. long, with spreading hairs; petals 6 mm. long; ovules 9-10 to each placenta; seed 1, rugulose .. .. *F. cupularis* 5
      F. Sheath of floral leaves not tubular.
        G. Leaves ovate, pubescent above, becoming glabrous; calyx 5-5½ mm. long, somewhat bristly; petals 6-7 mm. long; ovules 4-8 to each placenta .. .. *F. pseudo-flabellata* 6
        G. Leaves subterete or linear.
          H. Leaves glabrous above or almost so; calyx 5-8 mm. long, almost glabrous; ovules 3-13 to each placenta; maritime plant .. .. *F. pauciflora* 7
          H. Leaves and branches whitish-papillose; calyx 7½ mm. long, densely pubescent; petals 10-12 mm. long; ovules 6-11 to each placenta; inland plant .. .. *F. subteres* 8

A. Leaves sessile or subsessile, with revolute margins.
  I. Leaves more or less white-incrusted, the internodes very short; calyx about 5 mm. long, pubescent all over; flowers mostly solitary, except in *F. foliosa.*
    J. Leaves linear or oblong, clustered at nodes.
      K. Calyx-teeth and petals 5; seeds papillose.
        L. Leaves 1-4 mm. long, the midrib hidden; ovules 2-6 to each placenta; seeds 3-5 .. .. *F. cinerea* 9
        L. Leaves 3-7 mm. long, the midrib exposed; flowers in dichotomous cymes; ovules 10-12 to each placenta; seeds 9-15 .. .. *F. foliosa* 10
      K. Calyx-teeth and petals usually 4; leaves 2-5 mm. long the midrib concealed; style-branches and placentas usually 2; ovules 1, rarely 2, pendulous from the middle of each placenta; seeds 1-2, smooth .. .. *F. sessilis* 11
    J. Leaves subterete, mostly opposite, spreading; ovules 2-5 to each placenta; seeds 5-8 .. .. *F. muscosa* 12
  I. Leaves not white-incrusted, glabrous above, ovate-lanceolate, subcordate at base; internodes rather long; calyx glabrous in upper part; ovules 1-2 to each placenta; seeds 3, pubescent *F. cordata* 13

SECTION II. *Basigonia.* Placentas basal, 3, rarely 2; ovules 1 to each placenta, on long funicles, which are bent downwards near summit; leaves shortly petiolate.

M. Leaves glabrous above or almost so.
  N. Hairs of branches and calyx straight, minute; leaves linear; calyx 4-5-toothed, 5-7 mm. long; petals 4-5, 7-9 mm. long .. *F. eremophila* 14
  N. Hairs hooked or curved on branches or calyx or both; calyx usually 5-toothed.
    O. Leaves linear, subterete, glandular-dotted above; branches with hooked hairs; calyx 5-9 mm. long, subglabrous; petals 8-12 mm. long; seeds smooth .. .. *F. gracilis* 15

O. Leaves linear, lanceolate or oblong; branches and calyx with hooked hairs.
P. All leaves linear or lanceolate, 1-2 mm. broad; calyx 6-7 mm. long .. .. *F. uncinata* 16
P. Upper leaves linear or oblong, lower ones lanceolate or elliptic, 2-4 mm. broad; calyx 7-10 mm. long .. .. *F. hamata* 17
M. Leaves pubescent above; all hairs straight or almost so.
Q. Hairs on young leaves, branches or calyx rather long and bristly; leaves flat or with slightly recurved margins.
R. All hairs bristly; leaves ovate or oblong, 2½-9 mm. long, 1-5 mm. broad; seeds smooth or rugulose .. .. .. *F. serpyllifolia* 18
R. Hairs of calyx and flowering branchlets only bristly; leaves oblong to ovate-elliptic, 3-10 mm. long, becoming glabrous above, 3-10 mm. long, 1-4 mm. broad; calyx 5-8 mm. long; seed 1, smooth .. .. *F. latior* 19
Q. Hairs of leaves, branches and calyx minute.
S. Calyx 6-10 mm. long; seeds smooth.
T. All leaves ovate or amost orbicular, flat, glandular-dotted below, 3-10 mm. long, 2-7 mm. broad, the petiole conspicuous; calyx 6-8 mm. long .. .. *F. planifolia* 20
T. All leaves linear or oblong, with revolute margins, 2-8 mm. long, 1-2 mm. broad; calyx 6½-10 mm. long; petals 9-10 mm. long .. .. *F. connata* 21
S. Calyx 5-7 mm. long; leaves linear to oblong or ovate, pubescent above, 2-6 mm. long, 1-3 mm. broad, the margins usually loosely recurved.
U. Calyx with short bristly hairs, 5-toothed; petals 6-8 mm. long; seed usually 1, papillose .. .. *F. flabellata* 22
U. Calyx minutely pubescent, 4-5 toothed; petals 8-10 mm. long .. .. *F. angustipetala* 23

The localities for the new species described by Mr. Summerhayes are given below. Most of the species in the section *Basigonia* were formerly placed under *F. serpyllifolia*, Lindl.

1. *F. densa,* Summerh. l.c. 373.—Fowler's Bay to Nullarbor Plain.—Western Australia.

5. *F. cupularis,* Summerh. l.c. 371.—Beside salt lake, Koonamore.

6. *F. pseudo-flabellata,* Summerh. l.c. 372.—Lake Harry (N.E. of Marree).

7. *F. pauciflora,* DC. According to Summerhayes the type, which is characterised by rather short blunt leaves, usually small dense dichotomous cymes and ovules 6 to 15 to each placenta, is confined to the coasts of Western Australia.

Var. *longifolia,* Summerh. l.c. 365. Leaves 5-12 mm. long, glabrous above, longer and apparently narrower than in type; ovules 3-8 to each placenta; floral leaves usually as long as or longer than calyx = var. *trichosticha,* Summerh.—Islands off the coasts of Eyre and Yorke Peninsulas; Port Pirie.—Western Australia.

Var. *fruticulosa* (DC.) Summerh. l.c. 366. Leaves 3-7 mm. long, glabrous or with a minute scattered pubescence and sometimes a few white scales above; ovules 3-6 to each placenta (14-18 in the capsule).—*F. fruticulosa,* DC., but not of other authors. *F. pauciflora,* Fl. S. Aust., p. 392, pl. 36, figs. 1-6. The common form all round our coasts and sometimes near salt lakes or salt swamps inland. —Victoria; Tasmania. I cannot satisfactorily distinguish var. *Gunnii,* Summerh., so gradual is the transition in various specimens from leaves almost glabrous on the upper face to those with microscopic more or less scattered hairs or a partial scaly covering.

8. *F. subteres,* Summerh. l.c. 369.—Mount Lyndhurst; Leigh's Creek (both in Flinders Range).

9. *F. cinerea,* Summerh. l.c. 356.—Ooldea.—Western Australia.

11. *F. sessilis,* Summerh. l.c. 353.—*F. fruticulosa,* J. M. Black non D.C., Fl. S. Austr., 393, pl. 36, figs. 10-14.—Along the Great Bight and on East Franklin Island; Yorke Peninsula.—Victoria (Murrayville); Western Australia.

14. *F. eremophila*, Summerh. l.c. 375.—Near Fowler's Bay; Ooldea.

15. *F. gracilis*, Summerh. l.c. 380.—Near Lake Eyre; W. of Port Augusta, Swan Reach (River Murray).—N.W. Victoria; Western New South Wales.

16. *F. uncinata*, Summerh. l.c. 381.—Eringa; between Dalhousie and Blood's Creek; near Ferdinand River; Minnie Downs (all in the Far North).—Western New South Wales.

17. *F. hamata*, Summerh. l.c. 381.—Mount Parry (Flinders Range); Peake Station; near Cooper's Creek.—Western New South Wales and Queensland.

18. *F. serpyllifolia*, Lindl. The true *serpyllifolia* is near *flabellata*, but has longer and more bristly hairs on the calyx leaves and branches, although the leaves, which are broader in *serpyllifolia*, may in both species, and also in *latior*, become almost glabrous with age. Both these species, as well as the closely allied *connata*, have usually pale pink petals which dry almost white.—Marree; Oodnadatta; Innamincka; Cordillo Downs; Diamantina River; Arkaringa Creek; Hawker (Flinders Range).

19. *F. latior*, Sprague et Summerh. l.c. 376. Flowers in our specimens bright pink or purplish and retaining this colour when dry. This species scarcely differs from the preceding except in its leaves, which are rather sparsely dotted with minute hairs, scarcely visible except under the lens, whereas *F. serpyllifolia* has dense conspicuous bristly hairs on all the young stem-leaves and floral leaves. These hairs are especially easy to detect along the margins.—Abminga Creek (Far North.)—Western New South Wales.

20. *F. planifolia*, Sprague et Summerh. l.c. 377.—Mount Lyndhurst and northwards to Lakes Eyre and Blanche; Oodnadatta; near Everard Range.

21. *F. connata*, Sprague, in Kew Bull., 1925, p. 426.—*F. serpyllifolia* J. M. Black, Fl. S. Austr., 393, partly, not of Lindl., pl. 12, p. 186, figs. 9, 10, 11.—Hawker; Leigh's Creek; Koonamore; Morgan, Tarcoola.—Central Australia; Western New South Wales.

22. *F. flabellata*, Sprague in Kew Bull., 1925, p. 427.—*F. serpyllifolia*, J. M. Black, Fl. S. Austr. 393 partly, not of Lindl., pl. 12, p. 186, figs. 7, 8, 12, 13.—Frome River, near Marree; Diamantina River; Cordillo Downs.—Western Queensland.

23. *F. angustipetala*, Summerh. l.c. 374.—Farina; Murnpeowie; Strzelecki Creek.—N.W. Victoria; Western New South Wales.

VIOLACEAE.

Clelandia, nov. gen. Sepala 5, aequalia; petala 5, sessilia, patentia, quintum brevissimum, fere glanduliforme, valde depressum incrassatumque; antherae liberae, connectivis in appendiculam membranaceam ultra loculos productis, filamentis perbrevibus; ovarii placentae 3, circ. 2-ovulatae; stylus simplex, apice incurvus, stigmate minuto; capsula coriacea, trivalvis, unilocularis, loculicide dehiscens, flore persistente suffulta, valvis medio placentiferis; folia alterna, stipulis minutis.

This new genus does not appear to fit well into any of the established tribes of the family *Violaceae*. It has the irregular (zygomorphic) corolla of *Violeae*, the 5th petal being depressed, shortened, and thickened until it resembles a linear transverse gland, but none of the petals are spurred or saccate as in that tribe. It seems nearer to *Rinorea (Alsodeia)* in the tribe *Rinoreae*, which has also sessile or subsessile petals, but they are all equal or almost so, the corolla being regular or actinomorphic. In the species here described the half-dozen ovules which occupy the ovary (about 2 to each of the 3 placentas) are in the fruit reduced to one rather large seed which completely fills the capsule, the valve to whose placenta it is attached being longer and deeper than the 2 others. The style is curved near the summit, as in several species of *Violeae*, whereas in *Rinorea* it is straight. The genus is named after the discoverer, Professor J. B. Cleland.

Clelandia convallis, nov. sp. Fruticulus glaber; folia lineari-lanceolata, 10-15 mm. longa, 2 mm. lata, plana, rigidula, recurvo-mucronata, basin versus angustata, nervo mediano subter prominente, marginibus leviter recurvis; stipulae minutae, subulatae, caducae; pedunculi axillares, solitarii, uniflori, 6-12 mm. longi, bracteati, demum saepe recurvi; sepala tenuia, ovata, acuminata, 3-5 nervia, circ. 4 mm. longa; petala 5, quorum 3 truncato-obovata, circ. 3 mm. longa, quartum interdum paulo minus, quintum ad lineam transversam incrassatam reductum; antherae in appendiculam membranaceam semi-circulatam desinentes; ovarium subglobosum, glabrum; capsula oblique globosa, 4½ mm. longa; duabus valvis tertiâ seminiferâ sacculiformi minoribus; semen unicum, ovoideum, 3½ mm. longum, capsulam explens, testâ crustaceâ, brunneâ, punctulatâ, arillo crasso, albo, funiculo brevi. (Tab. II., fig. 3.)

Wilpena Pound, a broad valley enclosed by hills, in the Flinders Range. Collected by Professor J. B. Cleland at the end of November, 1930.

SOLANACEAE.

Solanum fasciculatum, F. v. M. This plant, which was united by Bentham with *S. simile*, F. v. M., and which I classed as a variety of that species in the Fl. S. Austr., appears to be entitled to specific rank on account of its narrow leaves, sometimes fleshy, channelled and only 2 mm. broad, its pedicels, which are solitary or rarely twin in the leaf-axils, never racemose on a common peduncle, as in true *S. simile*, and especially by its conical fruit, 15-30 mm. long, 6-8 mm. diam. near base, smooth and green when fresh, wrinkled when dry. Conical fruits occur in *Capsicum*, but this seems to be the only species in *Solanum* which ripens such fruit. It is a small shrub, usually under 1 m. high, inhabiting Eyre's Peninsula.

COMPOSITAE.

**Senecio pterophorus*, DC. On sandhills near jetty at Port Lincoln; coll. A. J. Warren, March, 1932. A radiate yellow-flowered perennial, about 1 m. high, from South Africa. It was recorded as introduced near Melbourne several years ago. The Port Lincoln specimens agree with descriptions in all points except that the achenes are not glabrous, but minutely pubescent under the lens. The nearly allied species *S. juniperinus*, L., is said by Harvey in the Fl. Cap. to have the achenes "glabrous or minutely puberulous," so that there is probably a variability on this point in *pterophorus* also.

Helipterum Troedelii, F. v. M., has, in some specimens from Hawker, only 5-8 flowers in the head.

DESCRIPTION OF PLATES.

PLATE I.

Fig. 1. 1. *Bulbine semibarbata* var. *depilata*: *a*, flower. 2. *Acacia barattensis*: *e*, flower, *f*, part of leaf. 3. *Carpobrotus Pulleinei*: *g*, seed; *h*, vertical section of fruit; *ilp*, inner lobes of perianth; *olp*, outer lobes of perianth; *st*, stigmas; *s*, seeds on parietal placenta; *opc*, outer coat or wall of pericarp (exocarp); *i*, inner wall of pericarp (endocarp). 4. *Disphyma australe*: fruit moistened and spreading open (viewed from above); *lp*, lobes of perianth; *b*, base of valves; *w*, wings of same; *cw*, cell-wings; *tub*, tubercles. 5. *Euphorbia Murrayana*: *b*, leaf; *c*, capsule; *d*, seed.

PLATE II.

Fig. 2. 1. *Calandrinia balonnensis*: *a*, stamen; *b*, seed; *c*, pistil; *d*, cross section of leaf. 2. *Calandrinia remota*: *e*, calyptra; *f*, seed; *g*, pistil; *h*, cross section of leaf; *i*, stamen. 3. *Clelandia convallis*: *j*, cross section of leaf; *k*, flower; *gp*, glandlike petal; *l*, stamen; *m*, seed; *ar*, aril; *rh*, rhaphe; *ch*, chalaza; *fun*, funicle; *n*, capsule opening; *o*, seed in closed capsule; *pc*, pericarp; *t*, testa; *epl*, endopleura; *ar*, aril; *ch*, chalaza; *alb*, albumen; *rad*, radicle; *cot*, cotyledons; *b*, base of capsule. 4. *Frankenia crispa*: *p*, seed; *q*, cyme; *r*, capsule; *s*, ovary spread open; *t*, cross section of leaf. 5. *Frankenia orthotricha*: *u*, cross sections of leaves; *v*, ovary spread open; *w*, calyx.

AN EXAMINATION OF THE BROWN COAL OF NOARLUNGA.

W. Ternent Cooke, D.Sc., A.A.C.I.

[Read July 14, 1932.]

The fact that this coal is found about 20 miles from the capital city, that fairly thick seams occur at reasonable depth, *e.g.*, one of 13 feet at about 50 feet, has resulted in some attention having been given to the deposit. A quantity of it has been mined, and examined locally and abroad. Full accounts of what has been done will be found in "The Mining Review" of the South Australian Mines Department, chiefly Nos. 37 and 45, of 1922, and 1926, respectively. Analyses 1 and 2, Table I. ("Review" 37, p. 59), give the average of five samples, (1), as raised, and (2), as air dried. The moisture content of the fresh coal is not excessive, for this class of material, but both ash and sulphur are distinctly high.

The material on which the present tests were done was obtained, doubtless, from the workings lying to the south-west of the township. About 20 lbs. had been kept in a jute bag indoors, for about two years, before it was used. Its moisture content was then found to be only 8%. This figure shows what might be done in the way of drying the coal in our climate by a suitable method of dry storage.

A quantity of the coal was finely ground and mixed; Analysis 3 gives its composition, 3a being calculated to an ash-free basis (Table I.). Unless otherwise stated, all analyses refer to moisture-free samples. The high content of ash and sulphur is again apparent.

It is well known that in the case of black coal the sulphur content is dependent to a decided degree on the adventitious mineral matter in the coal. It was thought worth while to see how far this might apply to the brown coal.

A quantity of the coal was subjected to water levigation, by stirring up with water, allowing to settle partly, decanting, and repeating the settling and decanting until four sediments had been obtained; the remaining suspension was then filtered. The five fractions, after drying, were analyzed for ash and sulphur. No. 1 is the portion which settled first, and No. 5 is the filtered suspension.

	1.	2.	3.	4.	5.
Ash	18·3%	20·0	13·2	12·9	10·8
Sulphur	5·65%	5·71	4·85	4·48	4·35

Apparently the sulphur content of the bulk coal is influenced distinctively, but not markedly, by the sulphur content of the ash.

The test was varied by employing the same procedure that is used on a large scale for the cleaning of black coals high in ash, *i.e.*, agitating the coal with a saline solution of density sufficient to allow the coal substance proper to float while the mineral matter settles out. A quantity of the coal, 50 grammes, was shaken with 300 ml. of a strong solution of magnesium chloride in a separating funnel, and, after settling, the mineral matter which separated out was drawn off from below. The shaking, settling, and removal of the mineral was repeated until no more sediment was apparent. By diluting somewhat the saline solution, the coal left was further separated into two portions, one settling out, the other sinking. Both lots, after thorough washing and drying, were analyzed—Analyses 4 and 5. Calculated to an ash-free basis, one gets the figures in analyses 4A and 5A, Table I. These results indicate that about 5% of sulphur and 6% of ash may be considered as essential components of the coal substance proper. However, this

rather high value for the sulphur content is not supported by the results obtained when the material is examined by the method given by Powell (1), which enables one to determine the sulphate, pyritic, and organic sulphur in the coal. Four estimations were made by Powell's method on a sample with 6·62% total sulphur. The mean values found were: "sulphate" sulphur, 0·59; "pyritic," 3·78; "organic," 2·20. The calculated value for the "organic," *i.e.*, the difference between the total and the sum of the "sulphate' and "pyritic" is 2·25%. The difference between the value 2·20% obtained for the "organic" sulphur obtained by Powell's method, and that, about 5%, indicated by the flotation experiments is not surprising when one remembers that the fine mineral matter would be absorbed quite appreciably by the colloidal coal.

Powell recommends estimating the iron content of that extract of the coal used for the determination of the "pyritic" sulphur; the values for iron and sulphur in this extract should be in the proportion demanded by the formula FeS^2, assuming, of course, that the sulphur is all more or less present as pyrites. In the present case, the figure 3·78% for "pyritic" sulphur would require 3·31% of Fe; the mean value found was 3·96%.

The Ash.

The ash from many experiments was collected and mixed. The ash is light red in colour, flecked with white spots. It does not sinter below 900°C. Its sulphur content is 7·44%, equivalent to 18·6% SO^3. Very little chlorine is present. A partial analysis gave the values: SiO^2, 29·14; Al^2O^3, 6·22; TiO^2, 1·56; Fe^2O^3, 24·58; CaO, 8·84; MgO, 4·5; and SO^3, 18·6%. Total, 93·44.

Distillation Tests.

"The Department of Mines Review," No. 37, 1922, contains a full account of distillation, and supplementary tests, carried out by G. D. Shaw, using the apparatus of the Geological Survey of Victoria. The author has carried out tests on three types of distillation apparatus: I., the Gray-King; II., the Fischer aluminium retort; and III., the "L. & N." assay retort. The results, with corresponding results by Shaw, are given in Table II., A, B, and C.

The Calorific Value.

"The Mining Review," No. 37, p. 77, gives the value 9085 B.T.U. for a sample of the oven dried coal. The value 9741, given in Table I., was obtained on a calorimeter of "works" type, and does not lay claim to high accuracy. This calorimeter, however, was found to give figures differing by not more than 5% from the figure assigned to a given sample of coal as evaluated by a bomb calorimeter.

Various formulæ are to be found in literature relating to coal which seek to correlate the calorific value of a coal with the figures given for its ultimate or proximate analysis. Several of these have been tried, but two only have been found to give results approximating the actual results found by experiment. Instead of the value 9741, Inchley's formula (2) gave 9362, and Schreiber's (3) 9858.

Parr (4) seeks to classify coals by making use of the observed calorific value in conjunction with certain anlaytic data. Applying his method to the present case, using the values 9741 B.T.U., 5·65% S, and 17·5% ash, we get the figure 12580 B.T.U. Using the values given in "Mining Review" *(loc. cit)*, after calculating to moisture free, i.e., 9085 B.T.U., 4·28% S, 23·5% ash, we get 12655 B.T.U. These calculated values, appertaining to what Parr calls "unit coal," would, according to Parr's classification, place the coal in the "brown lignite" class.

The foregoing tests have been made on samples which are representative of the bulk of the coal. A visual examination of a well-dried bulk lot shows, however that its texture is quite uneven. There is a decided proportion of a jet black material which is quite brittle and breaks with a conchoidal fracture; while the bulk of the coal is of a dull, light brown colour, having no definite fracture. Three types of material have been selected by picking over about 10 lbs. of the bulk sample. For convenience these are designated A, B, and C. A is the jetty black, B material of intermediate type, and C the dull brown. A closer examination of these portions is in progress.

TABLE I.

	Water.	C.	H.	S.	O.	N.	Ash.	Volat.	Fixed.	C./H.	B.T.U.
1	45·94	—	—	—	—	—	12·89	23·97	17·2	—	—
2	15·77	—	—	4·31	—	—	19·86	36·39	27·98	—	—
3	—	54·81	5·17	5·65	16·62	0·25	17·5	51·25	31·25	—	9741
3A	—	66·5	6·27	6·85	20·08	"	—	—	—	10·6	—
4	—	60·6	6·33	4·96	22·06	—	6·05	—	—	9·56	—
4A	—	64·45	6·74	5·28	23·53	—	—	—	—	—	—
5	—	61·3	5·2	4·94	21·99	—	6·6	—	—	11·77	—
5A	—	65·65	5·57	5·24	23·54	—	—	—	—	—	—

TABLE II.

A. *Results on Dry Basis.*

No. of and Type of Test.	Weight of Coal Used.	Gas, C. Ft./Ton.	Crude Tar, Galls/Ton.	Semi-coke, Cwt/Ton.	Moisture in Coal as Distilled	Final of Temp. of Distill.
I. Gray-King						
(A)	20·04 grms.	3026	28·2	11·3	11·6	652° C
(B)	19·8 grms.		"	11·9	"	650
II. Fischer	55 grms.	n.d.	28·7	11·6	11·6	550
III. "L. & N."	18 oz.	6100 (1)	26·7	10·2	19·1	620
IV. Shaw (5)	100 lbs.	5468	17·7	13·0	16·2	500

B. *Coals Used in A.*

	Volatile.	Fixed Carbon.	Ash.	Sulphur.	Moisture.
I., II., & III.	55·7	21·6	22·7	8·36	nil
IV. ...	36·13	27·95	19·68	3·59	16·2

C. *Gas Analysis.*(2)

	CO_2	CO	O_2	Unsat.	H_2	CH_4	C_2H_6	N_2
I. A	23·2	17·1	nil	2·9	n.d.	n.d.	n.d.	n.d.
B	19·4	16·2	—	2·6	n.d.	n.d.	n.d.	n d.
III.	27·0	11·3	0·2	1·0	35	9·65	2·6	12·0
IV.	Not recorded.							

REFERENCES.

(1) POWELL: U.S. Bureau of Mines, Tech. Paper No. 254, 1921.
(2) MITCHELL: "Fuel Oils," p. 46.
(3) "British Chemical Abstracts,' B., 1932, p. 166.
(4) "Jour. Indus. & Eng..Chem.," vol. xiv., 1922, p. 921.
(5) SHAW: "Mines Review," 37, December, 1922, p. 77.

(1) The coal is heated in superheated steam, extra hydrogen being formed.
(2) The crude gas is rich in sulphuretted hydrogen.

THE BIG DROP METHOD OF MEASURING SURFACE-TENSION.

By E. S. H. Gibson, B.Sc.

[Read August 11, 1932.]

The form of a liquid drop resting upon a plane horizontal surface which it does not wet depends upon the dimensions of the drop, the surface-tension of the liquid, and its weight per unit volume. The latter being known, the surface-tension can be determined by measuring the height from the equatorial plane, *i.e.*, the plane of horizontal section of maximum diameter to the top of the drop. This method was extensively employed by Quincke (1), who gave the following formula:— $\sigma = \frac{1}{2} e\, q\, h^2$ .. .. .. (1).

σ = Surface-tension.
e = Weight per unit volume.
h = Height of the summit of the drop above the horizontal plane of maximum section.

This was obtained by considering a vertical section one centimetre wide from that portion of the drop above the horizontal plane of maximum section (fig. 1).

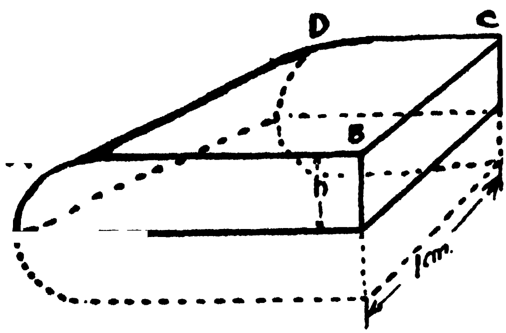


Fig 1.

Quincke (1) obtained the formula by equating the two horizontal forces acting, due respectively to surface-tension and hydrostatic pressure under gravity. The values obtained for different liquids by Quincke, using this method, differed appreciably from those values obtained by other workers using the capillary rise method. He attributed these discrepancies either to the impurities in the air or to the fact that the angle of contact between the tube and the liquid was not zero.

Worthington (2), however, pointed out that Quincke had overlooked two factors which affect the actual value of h. Firstly, he said that the dimensions of the drops that were used were not large, so that possibly Quincke was not justified in ignoring the curvature at the summit of the drop. It is evident that in neglecting this curvature at the vertex we are neglecting the pressure due to this curvature transmitted to the whole area h in the above diagram, and if b is the radius of curvature in question the pressure disregarded is $\frac{2\sigma}{b} h$ .. (2)

The surface-tension has to balance this as well as the hydrostatic pressure, and in neglecting this we are led to too small a result.

Secondly, in neglecting the curvature in the horizontal plane, we evidently leave out of account the tension exerted along each edge, AB and CD, of the

slab. If R is the radius of curvature, the pressure produced is $\frac{\sigma}{R}$. This pressure helps to support the drop and tends to increase the value of h. By integration, Worthington shows that this correction is equivalent to $\frac{2}{3\cdot282}\frac{\sigma h}{L}$, where L is the radius of the equator of the drop.

The complete solution is, then, $\sigma = \frac{h^2}{2} e q + \frac{\sigma}{e} 2h \left[\frac{1}{b} - \frac{1}{3\cdot282\,L}\right]$

Finally, he says that if L exceeds two centimetres the value of b is so large that the correction involving the reciprocal of this expression is negligible On simplification the expression reduces to $\sigma = \frac{\frac{h^2}{2}}{1+\frac{h}{1\cdot641\,L}} e g$ .. .. (3).

To test the revised formula Worthington re-calculated many of Quincke's determinations, and showed that the latter's results for surface-tension could be made to agree with the results obtained by the capillary rise method.

This paper describes experiments undertaken, with water as the liquid, experimentally to verify an assumption customarily made—that the curvature at the vertex can be neglected when the radius of the maximum horizontal section exceeds 4 cms. Most workers (3) in this field have assumed that it is correct and used the simpler formula for computing their values of surface-tension. As there appears to be some doubt about some of the results of this method when employed to give the surface tension of mercury, it was thought that there might be some factor which had still been overlooked.

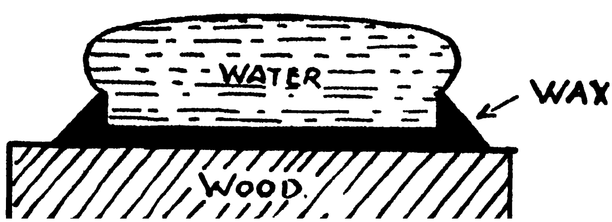


Fig. 2.

An attempt was made to prepare a flat surface which would not be wetted by water, and upon which large drops of water might be supported. It was first attempted to prepare such a surface by coating a glass or metal plate with paraffin wax; unfortunately, it was found to be impossible to prepare a satisfactory surface either by heating or by using a solution of the wax in benzine. Finally, flat dishes of wax were constructed. Pure paraffin wax was boiled with distilled water to remove any soluble impurities, and it was then cast into flat cakes on wooden blocks. The wooden blocks could be held in the chuck of a lathe, where, using a clean steel tool, the dish was turned out of the wax.

A typical section of the kind of dish which experiment showed to be most suitable is shown (fig. 2).

The important part was the edge; from this all irregularities had to be removed in the lathe. A set of these dishes was prepared and used continually for six weeks. If any dish suffered accidental contamination it could be remade by turning off the old surface and exposing a fresh one. The agreement of the results obtained by these dishes over so long a period justifies their employment at least for obtaining relative values of surface-tensions, even if they are unsuitable for absolute determinations.

The water used was from a still that was in constant operation, and it was stored in a deep bottle. A carefully cleaned pipette was kept immersed all but about 6 inches, the top half of this being the only portion touched while in use. To obtain a suitable drop the dish was rinsed and filled with water, at first quickly, and then slowly, until the water was about to run over the edge. Small, imperceptible irregularities in the edge of the wax would cause the edge of the drop to be distorted, but by looking at the equator this could be detected.

If the equator could not be raised sufficiently by adding more water, for it to appear horizontal as the cathetometer was moved across the drop, then the edge was remade.

The equator was observed by reflected light from a source level with the drop and about five feet in front of the drop. A narrow slit was fixed on to the side of the object glass of the telescope and in line with the axis of the instrument. The light passing through this slit was reflected back through the telescope from the vertical portion of the surface of the drop. With the smaller drops the equator appeared as a bright star, but in the case of the larger ones a bright horizontal line appeared which could be readily focussed on to the intersection of the cross wires in the telescope. The cathetometer read directly to ·001 cm. and was supported on a sheet of plate glass. This had been set down as nearly as possible horizontally for other work in this laboratory. As a test of its surface and horizontality the following set of readings was taken by traversing the top of a long narrow drop of water:—3·772, 3·773, 3·773, 3·771, 3·772, 3·772, 3·771 cms, a horizontal displacement of the cathetometer of about half a centimetre being made between each reading. This is further supported by the fact that although different portions of the plate were used on different days the results were always in agreement.

After reading the equator for three different settings the telescope was raised until the vertex could be viewed. This was illuminated by a source of parallel light standing about 20 feet away, and appeared as a sharp line on the cross wires of the telescope. Here three settings were again taken. This process was repeated twice, and, in the set of results used to draw graph I., for seven of the fourteen dishes employed, the total variation of h was ·001 or less, and in only one case as great as ·004 cms.

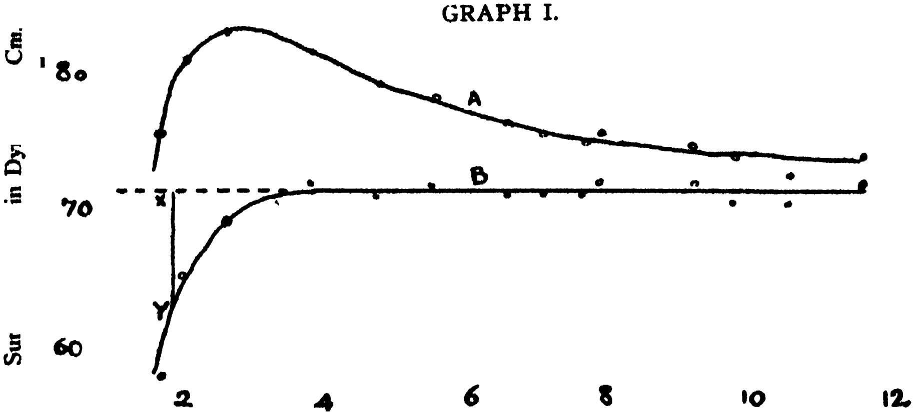
As the diameter of the drop was not required to any high degree of accuracy a pair of slide callipers was used to make this measurement. In graph I. A. the surface-tension calculated by Quincke's formula (1) has been plotted against the diameter of the drop. The graph shows that the value of the surface-tension so calculated varies considerably, rising to a maximum and then falling to a constant value, thus confirming Worthington's conclusion that the effects of the curvature at the summit and the curvature in the horizontal plane have conflicting effects upon the value of h.

The correction for the horizontal curvature can be made by employing Worthington's simplified formula (3), and the results using this expression have been plotted on the same graph I. B. Even then we are not making any allowance for the curvature at the vertex, and from the graph it appears that other workers have been quite justified in their assumption that the effect of this curvature is negligible when the diameter of the drop exceeds 4 cms.

To remove any doubt concerning the use of wax as a supporting medium the edges of a Petrie dish were polished till a good edge was obtained. It was found that this could be carefully filled and used as a support for a water drop that could be measured. The following three averages were taken on three samples of the same water as used above, employing a dish with a diameter of 6·6 cms. $h =$ ·395, ·396, ·395. The average surface tension calculated from these is 71·5 dynes per cm.

The vertex of a small circular drop is curved in two directions at right angles, and it was thought that if rectangularly shaped drops could be prepared some further light would be thrown on this problem. For with a drop of this nature, if the length exceeds the limit of 4 cms. laid down by Worthington and confirmed here by experiment as sufficient to render the curvature in a vertical plane of no

GRAPH I.

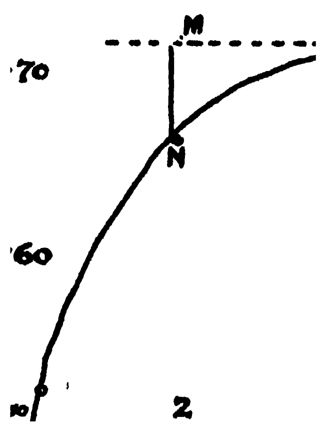


Diameter of Drop in Cms.

A. Gives the relation between the surface-tension obtained by using (1) and the diameter of the drop.

B. The same results have been recalculated using (3).

GRAPH II.



Width of Drop in Cms

Gives the relation between the width of the rectangular and the surface tension calculated, using (1).

account, then only the curvature in the perpendicular plane would have to be considered.

A number of attempts was made to prepare a suitable wax dish with parallel sides, but the difficulties in machining these edges could not be sufficiently overcome to make the results reliable. A built-up dish of wax and glass was an improvement but, finally, a sheet of plate glass with plane polished edges was

found to work admirably when supported horizontally. A set of plates was prepared and waxed on metal cylinders to act as supports. These plates could be cleaned with hot chromic acid and washed in boiling water; but more care was required in levelling the plates and forming these drops than in setting up the circular drops. The plates were all approximately 7·6 cms. long, and their widths varied from 1·2 cms. to 5·7 cms.

The results obtained by using this set of plates have been calculated, using formula (1) and graph 2 shows how the surface-tension so calculated varies with the width of the drop.

Here again the curve becomes appreciably straight when the width of the drop approaches 4 cms., indicating that the curvature at the summit of the drop has ceased to have any measureable effect on the value of the surface-tension. Thus Worthington's calculation is again confirmed.

In both sets of results the curvature at the vertex of the drop has been neglected. It has been explained above that the circular drops have a two-dimensional curvature, whereas the rectangular drops have appreciable curvature at the vertex in one direction only, the length, 7·6 cms., being well above the limit (4 cms.) beyond which this curvature has no further influence on the surface tension.

Treating mathematically the rectangularly-shaped drops, the first correction factor (2) which was to account for the curvature at the vertex of the drop must be altered from $\frac{2\sigma}{b}h$ to $\frac{\sigma}{b}h$, as we have here only half the curvature met with in the circular drop. This means that taking drops with the same width, the discrepancy between the average value of the surface-tension, 71·5 dynes per cm. in each case, and the value obtained by the simplified formula (3), should in the case of the rectangularly-shaped drops be only half that shown by the circular drops.

Taking the rectangular drop 1·9 cms. wide, the difference M N is 5 dynes per cm., and by interpolation on the graph for the circular drops the difference X Y is 9 dynes per cm., or approximately twice that for the rectangular drops.

This experimental work has shown that the assumption that has been made by the many workers in this field, *viz.*, that if the diameter of the drop exceeds 4 cms. the simplified formula, omitting the curvature at the summit of the drop, can be employed, is justified. Thus the diameter need not be measured, so long as this limit is exceeded.

In conclusion, I wish to express my gratitude to Professor Kerr Grant for his permission to carry out his work, and to Mr. R. S. Burdon for suggesting the problem.

Since writing the above an attempt has been made to compare the use of the rectangular drop for obtaining the value of the surface-tension of a liquid, with the use of the capillary rise in a narrow tube.

The diameter of the capillary tube was found by weighing two mercury threads of different lengths, the average diameter so found being ·0472 cms.

To assist in the measurement of the capillary rise above the surface of the water in the vessel, the following procedure was adopted. A bent glass rod with the lower end drawn out to a fine point was adjusted to the level of the water. By viewing the surface from underneath the setting could be made with precision by means of a long lever. A very fine mark was placed on this rod at approximately the level of the meniscus in the capillary tube. The capillary tube was moved down between the first four readings and between the others it was raised

about $\frac{1}{2}$ cm. In each case the vertical distance between the meniscus and the fine mark was measured, using the cathetometer. The accuracy which can be obtained using this method is indicated by the values of the capillary rise. This is found by adding to the readings taken, the length of the pointer used. The values of h obtained were 6·218, 6·213, 6·208, 6·203, 6·204, 6·194, 6·205, 6·197 cms. The average value of the surface-tension calculated from these measurements was 71·8 dynes per cm.

Using a glass plate 4 cms. wide and 7·2 cms. long as described above, and using the same supply of water and immediately after using the capillary tube, the following average values of h were obtained for four different drops, ·3828, ·3840, ·3831, ·3840. The average value of the surface-tension obtained from these was 72·1 dynes per cm., or approximately the same value as obtained by the other method.

Thus it has been shown that these two methods do agree, and further support is given to the big drop method of measuring the surface-tension of liquids.

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SOME BOTANICAL FEATURES OF THE DISTRICT BETWEEN COCKATOO CREEK AND ALICE SPRINGS, CENTRAL AUSTRALIA.

By J. Burton Cleland, M.D.

[Read September 8, 1932.]

Cockatoo Creek is situated by road 200 miles north-west of Alice Springs. Our camp was situated some miles east of the usual track to Tanami, and not quite half-way between Alice Springs and that township. The route taken lay for 100 miles along the Darwin track, and then, for approximately the same distance, east and a little north.

For the first 13 miles the route lay through rocky hills comprising part of the MacDonnell Ranges. The shrubs comprised the two Corkwoods *(Hakea lorea* and *H. intermedia)*, the Native Pomegranate *(Capparis Mitchelli)*, the white-stemmed Cabbage Gum *(Eucalyptus papuana)*, Beefwood *(Grevillea striata)*, Needlewood *(Hakea leucoptera)*, Native Pine *(Callitris robusta* var. *microcarpa)*, Dead Finish *(Acacia tetragonophylla)*, Whitewood *(Atalaya hemiglauca)*, Mulga *(Acacia aneura)*, the beautiful flowering *Tecoma doratoxylon, Prostanthera striatiflora*, Native Figs, the Witchetty Acacia *(A. Kempeana)*, and other plants. Red gums *(Eucalyptus rostrata)* and a *Melaleuca* grew in the creek beds.

The country from 13 miles to 100 miles, where we turned off, consisted of plains mostly covered with Mulga, and crossed occasionally by low, rocky ranges. Higher mountain masses were visible on either side in the northern part of this track. The plains were chiefly covered with Mulga *(Acacia aneura)*, of which there seemed to be several forms differing in the length and breadth of the phyllodes. In one species locally called "Feather-leg Mulga," the younger trees have horizontal branches right down to the base, which finally disappear in old trees. The Mulga varies in denseness, sometimes being very close together, so that there is difficulty in passing through it, but more frequently with the bushes sufficiently separate to be able to drive between them. Occasionally considerable grassy patches were met with, sometimes half a mile or more in extent, covered with grass and with only an occasional Mulga. A considerable quantity of dry grass occurred under the Mulga, chiefly a species of *Aristida*. Mixed with the Mulga were varying numbers of Witchetty Bushes or "Granite" *(Acacia Kempeana)*. Other shrubs and trees met with occasionally amongst the Mulga were the two Corkwoods, Needlewood, Beefwood, Ironwood, Bloodwood, Bullock-bush *(Heterodendron oleifolium), Eremophila, Acacia Victoriae*, and a few Bassias and Kochias. Termites' nests were prominent features in places. At 25·4 miles, and again in places further north, as near Prowse's Gap, the Coolebah *(Eucalyptus microtheca)*, with its rough box base, was seen. Around Burt's Well, at 38 miles, were species of *Swainsona, Goodenia*, various small grasses and composites, and a creek with Red Gums. At 45 miles, Cassias and *Codonocarpus* were seen. Porcupine Grass *(Triodia)* was met with in sandy patches just beyond Connor's Well at 62 miles. The broad-leaved mallee *(Eucalyptus gamophylla)* was met with at 65 miles, at 71 miles, and in places throughout the journey. A gap in Hann's Range was passed through at 74·5 miles, and amongst the rocks were seen *Santalum lanceolatum*, a very viscid Porcupine Grass, the beautiful *Grevillea juncifolia* with its orange flowers, *Goodenia Ramelii*, and the beautiful *Dicrastylis ochrotricha* ("var. with narrow leaves and exsert style"—Botanic Gardens, Sydney). Ryan's Well was passed at 81 miles. At 90 miles another rocky ridge was crossed, and amongst the rocks grew a sticky prickly sweet-scented Acacia

(*Acacia patens*), a broad-leaved *Cassia*, another species of *Hakea* with broader leaves than the two other Corkwoods, *Sarcostemma*, *Indigo*, *Erythrina vespertilio*, *Ficus*, *Atalaya*, an Acacia (*A. coriacea* var. *angustior*) with very long, narrow phyllodes, and other plants. Similar plants were met with at Prowse's Gap, crossed at 93·5 miles. Here also appeared a broad-leaved rubiaceous shrub (*Plectronia latifolia?*).

The last four miles on the Darwin track were through open grassy country with scattered shrubs. At the turn-off at 100 miles, we entered an open patch of red loamy sand on which various shrubs grew, amongst them an *Exocarpus* and an *Acacia*, as well as a *Triodia*.

We camped for the night in the bed of Woodforde Creek at 107 miles. Here Red Gums grew in the dry sandy bed, and along the banks and on the adjacent plains were occasional Mulgas, *Hakea intermedia*, and Beefwood, and as under-shrubs several Malvaceous plants and a *Phyllanthus*, as well as such grasses as *Andropogon*, *Aristida* and Buffel Grass (*Pennisetum ciliare*).

Next day the track continued eastwards and a little north, travelling sometimes over extensive plains and sometimes on the level between ranges and crossing dry sandy watercourses from time to time. Small hills of granite boulders were seen at times, and in the distance to the north bold mountain bluffs. The level country was covered either with scattered Mulga and grass, or with a mixture of various shrubs and grass. The plants already referred to in these formations were still present, and others appeared from time to time. The broad-leafed Rubiaceous shrub *Plectronia latifolia?* was seen occasionally from now on to Cockatoo Creek, as well as *Atalaya hemiglauca*, *Erythrina*, *Carissa Brownii*, Ironwood (*Acacia estrophiolata*) and Kangaroo Grass. A hill of white quartz was passed at 113 miles, and soon after a sandy creek with *Melaleuca*. The Lander was crossed at 121 miles at Pine Hill Station, a deserted homestead with an old garden fig still growing. The course of this wide, dry sandy watercourse was now more or less closely followed to 158·5 miles, a rocky defile called the Lander Rocks being traversed at 147·5 miles. For a mile or so on each side of the creek the country was often open and park-like, with trees such as the white-stemmed *E. papuana*, Bloodwoods, Beefwoods, Corkwoods, *Capparis*, etc.

At 136·5 miles was a small outcrop of granite rocks from which a good view of Mount Thomas, the highest point in Central Australia, was obtained to the south-west across the Lander and a Mulga plain. Around and between these rocks grew *Carissa Brownii*, *Pittosporum phillyreoides* (leaves broader than in the south), the sticky, prickly Acacia (*A. patens*) already mentioned, *Santalum lanceolatum*, *Tecoma doratoxylon*, *Isotoma petraea*, *Trichodesma zeylanicum*, and the fern *Notholaena*. *Ficus platypoda* spread over the rocks, growing from a fissure between them.

A patch of Gidyea (*Acacia Cambagei*), the only one seen on the trip, was noticed at 145·5 miles. A small tree without flowers or fruits and rather resembling Bullock-bush was first seen at 154·5 miles, and thereafter occasionally till Cockatoo Creek was reached. Occasionally patches of grassy country, boggy in wet weather, were noticed.

Coniston Station (Randall Stafford's), on the Warburton, was reached at 166·5 miles. Its wide, deep bed was covered with loose sand and was difficult to cross. In its bed grew *Cyperus*, sp., a large *Senecio* (*S. magnificus*), *Olearia subspicata*, *Acacia Jennerae*, *Dodonaea petiolaris*, Red Gums and various grasses, and on the banks *Leschenaultia divaricata* and *Triodia*. Mount Gardiner was seen some miles to the south-east.

At 172 miles, a Red-gum creek with *Melaleuca* was crossed. *Salsola kali* grew in places on the plains under or between the shrubs. Brookes' Soak was reached at

182·5 miles, just a small spring in the creek-bank. Supple-jack *(Ventilago viminalis)* was seen occasionally from here onwards, the road passing various stony hills and rugged ranges, those of a granite nature sometimes showing Native Pines *(Callitris)* on them, those that were of quartzite Porcupine Grass. Cockatoo Creek was reached at 201 miles from Alice Springs.

THE VEGETATION OF COCKATOO CREEK.

The creeks run mostly towards the north, eventually petering out on flats. Such is the fate of the Lander, of Cockatoo Creek, and of the creek at Brookes' Soak.

The camp at Cockatoo Creek was situated on this broad and dry watercourse at a spot where it broke up into several ana-branches. Before dividing, the main bed, composed of coarse clean sand, was about 44 yards across, the banks being 2 ft. 6 in. to 4 ft. high. After dividing into smaller watercourses, several elongated islands, covered with grasses and scattered shrubs and trees, resulted. On these islands and in the watercourses part of the native population of about 150 were camped behind low bough shelters, their fires at night making a picturesque scene as the irregular white trunks and branches of the River Red Gum *(E. rostrata)* were lit up from below, and equally picturesque in the evening when the yellows and purples of the after-glow were seen through the trees. Beside the camp was a small granite knoll. A mile to the west was a taller hill, its top denticulated with upstanding rock masses. On the plains between were camped the rest of the natives. Here again, after the sun set, varied delicate shades of colour contrasted with the bold silhouette of the mountain masses in the clear sky of Central Australia, and later in the evening the young moon, seen between the spreading branches of the Bloodwoods and Red Gums, with the hills on either side, made still another picture of delicate beauty.

Red Gums indicate the course of the creek and its tributaries. Many of the trees are probably very old. The trunks are not very thick, but short, bent and irregular. The barrels of these trees are whiter (though sometimes bronzed), the opercula shorter, and the sucker branches more quadrangular with broader glaucous leaves than those near Adelaide.

On the islands and banks occur Bloodwood, occasional Erythrinas with their bat-shaped leaves, *Capparis*, Ironwood, Beefwood, etc.

A very abundant undershrub with purplish flowers and slightly scented leaves is *Pterocaulon spachelatum*. Other shrubs and undershrubs are *Santalum lanceolatum, Salsola kali, Trichinium, Pollinasia viscosa, Alternanthera, Achrysanthes aspera, Acacia farnesiana, Acacia Jennerae*, Cassias, *Psoralea, Crotalaria dissitiflora*, several other peas, *Halorrhagis ciliata* (?), *Trichodesma zeylanicum*, several Malvaceae, *Stemodia viscosa, Clerodendrom*, sp., allied to *C. Cunninghamii*, a prickly *Solanum, Cynanche floribundum* (leaves and fruits eaten by the natives), *Oldenlandia (Hedyotis)*, sp. nov. (?), *Senecio magnificus*, and *Helichrysum apiculatum*. The Cucurbitaceous *Melothria maderaspatana*, with small red fruits, is a twiner and *Ipomea racemigera* (?) a trailer. Small herb-like plants include *Euphorbia Drummondii, Phyllanthus*, sp., *Bergia trimera, Nicotiana suaveolens* and *Commelina ensifolia*. A few plants of Nardoo *(Marsilea Drummondii)* were seen. *Cyperus rotundus* grows on the adjacent flats, but was not in leaf; its tubers ("yelka"), however, were dug up by the natives and used for food. Another *Cyperus* was present in the creek bed. About 20 species of grasses grew in the bed or on the banks. These include *Eulalia (Pollinia) fulva, Amphilophis (Andropogon) intermedia* var. *pabularis, Themeda avenacea* (growing on the banks, up to 6 ft. high—the boys use the long, dry straws as miniature spears), *Perotis rara, Panicum decompositum, Brachiaria distachya, B. piligera* var. *intercedens* (trail-

ing), *Digitaria Brownei (Panicum leucophaeum), Setaria surgens* (?), *Aristida Browniana, A. arenaria, Eriachne obtusa, Pappophorum avenaccum, Triraphis mollis, Eragrostis parviflora, E. speciosa, E. japonica, E. diandra, Chloris virgata,* and *Ch. acicularis.*

THE BOLD ROCKY GRANITE HILL A MILE WEST OF THE CAMP AT COCKATOO CREEK.

In the crevices and shelter between the great rocky masses a variety of scattered plants found growing space, some being peculiar to such a situation, but others found also along the dry watercourses, or evidently "strays" from the surrounding plain. The plants noted comprise the rock-fern *Nothalena Brownii;* grasses such as Kangaroo Grass *(Themeda triandra),* two Andropogons (one *A. exaltatum,* with scented leaves), two Panics *(Panicum decompositum* and *Digitaria Brownii,* otherwise *Panicum leucophaeum),* a wavy *Aristida* (probably the same as on the plains), another *Aristida,* two *Pappophorums (P. avenaceum* and *P. Lindleyanum,* 20 ins. high, somewhat spreading, tufted, with heads like drum-sticks), and a rather prickly *Eriachne,* bushy, up to 20 ins. high and in diameter, hard to pull up as it grew amid the granite boulders; two sedges, a sticky *Cyperus* and a *Fimbristylis* (quite dried up); *Santalum lanceolatum, Bassia,* sp., *Trichinium, Achrysanthes aspera* with recurved spines on the fruits, *Capparis Mitchelli;* Leguminosae such as *Acacia Victoriae,* Mulga *(A. aneura,* a stray), the "Witchetty bush" or "Granite" *(A. Kempeana),* a *Cassia, Indigofera hirsuta* and a glaucous Indigo, *Glycine clandestina* (?), and a bean tree *(Erythrina vespertilio); Euphorbia Drummondii* (?); occasional shrubs of *Atalaya hemiglauca;* two Malvaceous plants; *Hybanthus enneaspermus; Carissa Brownii* var. *lanceolata* (Apocynaceae, two thorns at the bases of the leaves); *Sarcostemma australe* with intricately twined leafless snake-like branches; a *Heliotropium (H. asperrimum)* and *Trichodesma zeylanicum* with its showy flowers; the widely distributed *Prostanthera striatiflora;* the prickly *Solanum ellipticum; Eremophila,* sp.; the trailing Cucurbitaceous plant *Melothria maderaspatana;* the sticky *Goodenia grandiflora,* abundant on the southern aspect at the base amongst rocks; a Composite; a few shrubs of "Supple-jack" *(Ventilago viminalis);* and the small undershrub *Evolvulus alsinoides.* On some of the granite hills grew a number of stunted Native Pines *(Callitris robusta* var. *microcarpa),* and on others a few spreading figs *(Ficus platypoda).*

At the base of a picturesque granite knob near Brooke's Soak, several Cabbage Gums *(Eucalyptus papuana)* grew, making a beautiful picture with their pure white stems. Native Pines grew amongst the rocks, and other plants comprised the scented *Andropogon exaltatus, Eriachne scleranthoides, Cyperus,* sp., a *Trichinium* (new to me), *Indigofera,* several Malvaceous plants and two Solanums.

QUARTZITE HILLS.

Some of the quartzite hills were exceptionally rocky and jagged, and very difficult to climb on account of sharp tilted strata. On these grew Porcupine Grass *(Triodia,* sp.). One such hill was climbed some 5 or 6 miles east of Coniston and nearly opposite Mount Gardiner. On the sandy soil rising to its base grew clumps of *Triodia* (unidentifiable, not being in flower), as well as two mallees (the broad-leafed *Eucalyptus gamophylla,* and a slender-fruited species, *E. gracilis)* and the sticky *Acacia patens.* The Porcupine Grass extended up the hill, another species being also apparently present in dry runnels. The mallee extended only a short way. Other shrubs amongst the rocks were *Acacia spondylophylla,* an Acacia with narrow phyllodes, a *Cassia* (?), *Trichinium obovatum,* a shrub resembling Bullock-bush, the sticky *Goodenia grandiflora,* and one *Carissa Brownii.*

The Mixed Shrubs and Grass Plains.

The plains immediately round Cockatoo Creek are of the mixed shrub and grass type, not of the nearly pure mulga and grass kind. The soil is a sandy loam with coarse grains on top. There are about twenty small trees and tall shrubs, sometimes more, sometimes less, to the acre. The trees and shrubs are scattered or in small groups, the under-covering and open spaces being covered with a wavy *Aristida (A. arenaria)*, and in lesser amount a straight-stemmed *Aristida (A. Browniana)*, these grasses being in tufts often a foot or more apart. The wavy *Aristida* is known as "Seven-days Grass" and is poor feed. There is some Roly-Poly *(Salsola kali)*, an occasional *Trichinium obovatum, Solanum ellipticum, Trichodesma zeylanicum, Euphorbia eremophila* or climbing *Melothria maderaspatana*, and in places holding water, longer Kangaroo Grass. The principal shrub is often *Acacia Kempeana*, known as "Granite" or the Witchetty Bush from harbouring frequently the grubs of that name. It has somewhat broad phyllodes, heads in spikes, and half-a-dozen or so branches springing from the base and dividing several times as the outer ones diverge outwards, the arrangement of the branches being rather fan-like. There may be a little Bloodwood *(E. pyrophora?)*, Beefwood, Ironwood, *Atalaya hemiglauca*, a tree not in fruit resembling Bullock-bush *(A. notabilis)*, the Corkwoods *Hakea lorea* and *H. intermedia*, Needlewood *(H. leucoptera)*, Dead Finish *(Acacia tetragonophylla)*, Mulga *(A. aneura)*, *Capparis Mitchelli, Carissa Brownii, Eremophila* (Turpentine?), Supple Jack *(Ventilago viminalis)*, and *Cassia*.

I would like to express my indebtedness to Sir Arthur Hill, Director of the Royal Botanic Gardens, Kew, for the identification of the grasses made by Mr. C. E. Hubbard, and to Dr. Darnell Smith, Director of the Botanic Gardens, Sydney, and his staff, for the identification of a number of other plants.

These notes were made during the course of the Anthropological Expedition organised by the Board of Anthropological Research of the University of Adelaide and the South Australian Museum in August, 1931, and form part of an attempt to study the surroundings of the Australian aborigine in all their aspects. In great part the expense of the expedition was borne by a grant from the Rockefeller Foundation, administered by the Australian National Research Council, and I would like to express my appreciation of this generosity.

THE PARASITES OF THE "STUMPY-TAIL" LIZARD, TRACHYSAURUS RUGOSUS.

By PROFESSOR T. HARVEY JOHNSTON, University of Adelaide.

[Read September 8, 1932.]

The lizard, *Trachysaurus rugosus*, is widely distributed in the drier parts of Australia, and is especially common in South Australia. It is known variously as the shingle-back, stumpy-tailed, sleepy or sleeping lizard.

The ectozoa known to occur on this reptile are all members of the Acarida. The entozoa include Protozoa, Trematoda, Cestoda, and Nematoda.

ACARIDA *(Ixodoidea)*.

Ticks are present rather frequently on the species, especially in the auditory meatus, and may occur also behind the limbs. Two species have been described, *Aponomma trachysauri* Lucas, and *Amblyomma albolimbatum* Neumann.

Aponomma trachysauri (Lucas) Neumann.

It was originally described by Lucas (1861, 225), from European material, as an *Ixodes* and the host was quoted as *Trachysaurus scaber*. Neumann (1899, 43) transferred it to *Aponomma*, and, later (1911, 96), gave a short description of it in his Monograph. Ferguson (1925) referred to it in his key to Australian ticks, and stated that it was doubtfully placed on the Australian list, though the name *T. scaber* probably referred to *T. rugosus*. The possibility of the tick having become attached to the lizard while in captivity in the Paris Museum menagerie is mentioned. Neumann's key to the species has been reproduced by Patton and Cragg (1913, 622-3). Fielding (1927, 88) published an account of it, based on the earlier description and reproduced Neumann's figures.

Amblyomma albolimbatum Neumann.

This tick was described by Neumann (1907, 218) from male specimens taken from *Trachysaurus rugosus* in Holland. He gave a summary in 1911 (p. 86). Patton and Cragg (1913) referred to it in their key to species of the genus. Robinson (1926, 224) described both sexes and mentioned the presence of the parasite on that lizard as well as on *Diemenia superciliosa* (= brown snake, *Demansia textilis)* from Western Australia.

Ferguson (1925, 32-3) recorded it from the tiger snake (= *Notechis scutatus)* and *Trachysaurus* in New South Wales, and from a Western Australian "bob-tailed goanna." He also gave a key to Australian species of the genus based on earlier keys of Neumann and of Patton and Cragg (1913, 612-9). Fielding (1927, 86) published a brief account of the species from specimens collected in North Queensland from *Trachysaurus* as well as from *Varanus varius*. The species is fairly commonly met with on the sleepy lizard in New South Wales, Victoria, and South Australia.

ENTOZOA.

A number of these lizards have been examined for entozoa from time to time. Several different types of Protozoa have been met with, and occasionally cestodes and nematodes. Trematodes have been described from a specimen from the New York Zoological Garden, but they have not yet been encountered here, though searched for.

Protozoa.

Flagellata.

Flagellates were frequently found in the rectum, often in company with Oxyurid nematodes *(Veversia)*. No attempt was made to study these organisms beyond a broad identification.

Copromonas, sp. The species has an almost circular "body," about 0·015 mm. in diameter.

Bodo, sp. A long but very narrow species with a much wider fusiform posterior region, and with a flagellum about twice as long as the "body."

Trichomastix or *Trichomonas*, sp. A very minute form.

Sarcodina.

There appear to be two distinct species of endamoebae present in the rectum.

Endamoeba, sp. 1 (fig. 2) :—A rather compact small species measuring 0·025 to 0·03 mm. in diameter when all pseudopods are withdrawn, was present in the rectum. The ectoplasmic zone is about 3 to 5 μ in width, and is rather sharply marked off from the endoplasm. Locomotion is very slow. Pseudopods are relatively short, broad and blunt, may be developed from any part of the surface, and several may be present at one time. They are composed chiefly of ectoplasm. The encysted stage is spherical, measuring 0·018 to 0·03 mm. in diameter, and surrounded by a very thin cyst wall.

Endamoeba, sp. 2 (fig. 3) :—This is a much larger species, measuring 0·04 to 0·05 mm. in width, according to the degree of protrusion of the pseudopod. When the latter is fully formed, the organism may measure 0·07 to 0·08 mm. long. The ectoplasm is 5 to 10 μ in width, according to the condition of the relatively large pseudopod. The latter develops from one end and, when fully formed, the organism becomes more or less pryriform. At the opposite extremity a firmer region constitutes a short, bluntly rounded "tail" which is more or less persistent. Movement is more active than in species 1. The round cyst measures 0·042 to 0·045 mm. and exhibits very little ectoplasm. The nucleus has a diameter of about 12 μ. The parasite occurs in the rectum.

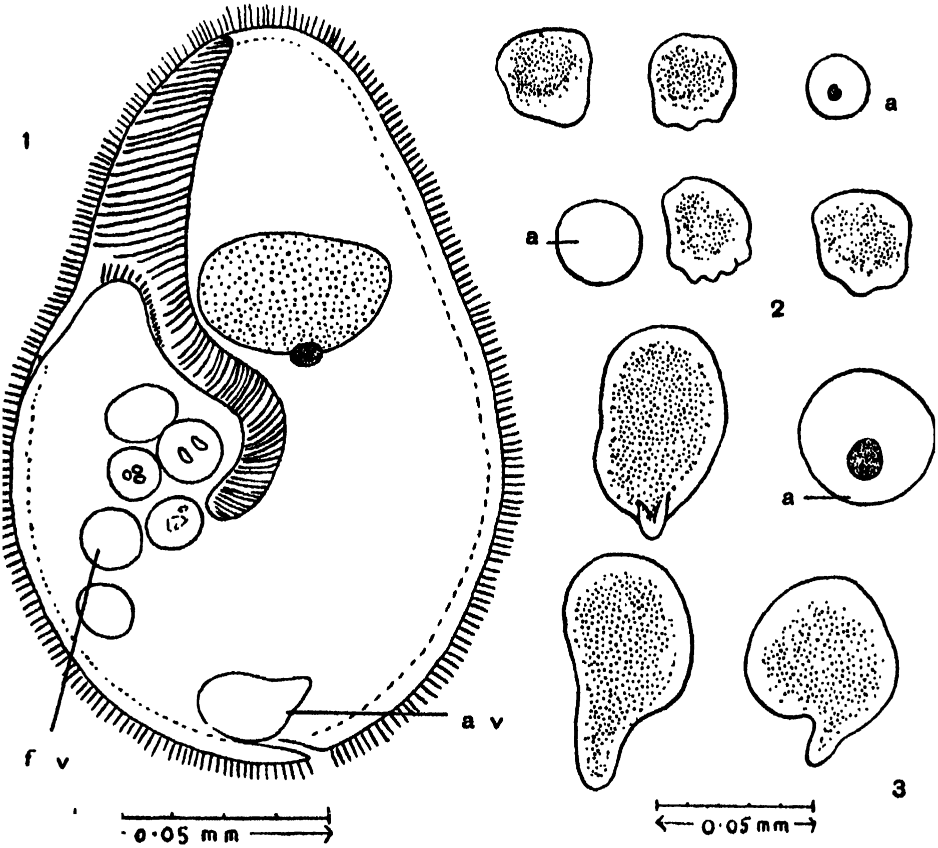
Ciliata.

Nyctotherus trachysauri, n. sp. (fig. 1).

This large ciliate was found in the rectum of several lizards, sometimes sparingly, sometimes in abundance. The length is about 0·14 to 0·16 mm., and breadth 0·10 to 0·11 mm. Some small, probably young, specimens measured 0·125 by ·075 mm. The anterior portion is slightly narrower than the posterior. The vestibule after dipping down into organism is of an even width, 0·01 mm., this portion being about 0·06 mm. long and slightly curved. While the cilia on the general surface are very fine and measure about 5 μ long, those in the vestibule are much coarser and are three times as long, especially at the beginning of the cytostome, becoming smaller in the cytopharynx. The cortex is about 8 μ thick. The medulla lying anterior to the meganucleus is much denser than the remainder. The meganucleus, which lies adjacent to the anterior half of the cytopharynx, is transversely situated, and measures 45 μ by 32 μ. The micronucleus, lying just behind it and close to the cytopharynx, measures about 10 μ. The anal aperture is not quite terminal, and its canal, which is about 15 μ long, passes inwards obliquely, nearly parallel to the margin of the organism.

Specimens remained alive for three days at room temperature in a receptacle containing lizard faeces and water (October). Smears containing the parasite have been deposited in the South Australian Museum.

Doflein (1928, 1,187) mentions one species, *N. harani* Grassi, as occurring in a reptile, a gecko, but most species from vertebrates are from Amphibia. The position of the anal pore, the form of the anal tube, and the position of the cytostome distinguish the parasite from all others whose descriptions are available. One species, identified by Raff (1911) as *Nyctotherus cordiformis* Ehrb., is very common in the rectum of Australian frogs.



Figs. 1, 2, 3.

Fig. 1, *Nyctotherus trachysauri;* 2, *Endamoeba,* sp. 1; 3, *Endamoeba,* sp. 2. a, cyst; a v, anal vesicle; f v, food vacuole.

Figs. 2 and 3 drawn to same scale.

TREMATODA.

Paradistoma trachysauri (MacCallum) Dollfus.

MacCallum (1921, 173) gave a figure and brief account of a small trematode, *Paragonimus trachysauri,* from the gall-bladder of a *Trachysaurus* which died in the New York Zoological Garden. As has been pointed out by Dollfus (1922, 329), the worm belongs to a quite different family and genus—*Paradistoma* Kossack (Dicrocoeliinae), and is intermediate between *P. mutabile* (Molin) and *Dicrocoelium concinnum* (Braun).

Paradistomum maccallumi, nom. nov.

MacCallum (1921, 176) described a second trematode from the gall-bladder of the New York animal and named it *Cephalogonimus trachysauri.* Chandler

(1923) excluded it from that genus and thought that it should be placed in a new one. Moghe (1930) followed Chandler and did not include it in his key to the species of *Cephalogonimus.* MacCallum did not see the termination of the cirrus and uterus, "though they disappeared behind the pharynx and mouth to terminate on the dorsal surface of the anterior end." The position of the testes and ovary and the character of the uterus are not those of *Cephalogonimus.* If one contrasts this species with that described by him as *Paragonimus trachysauri,* it will be noticed that the two are very similar and the general organography is practically the same. Apart from the difference in size, and especially in breadth, the main differences are the extension of the uterus beyond the ends of the intestine, the more voluminous and more-lobed crura, and the (probably) more forward position of the genital aperture.

The species is obviously a *Paradistoma* and closely related to, if not identical with, the preceding species. In view of the differences noted, it is advisable to re-name it as *P. maccallumi,* since the specific name is already preoccupied in the genus. Dollfus (1922) has emphasised the variability occurring in *P. mutabile.*

The genus *Paradistoma* is known to be represented in Australia by *P. crucifer* (Nicoll) Travassos—originally described (Nicoll, 1914) as a *Eurytrema*—from the gall-bladder of a limbless lizard, *Delma fraseri.* The latter is quoted in error by Travassos (1919) as *Dalura fraseri.*

CESTODA.

Oochoristica trachysauri (MacCallum) Baer.

MacCallum (1921, 229) gave a very brief description of *Taenia trachysauri* from a *Trachysaurus* which died in the New York Zoological Park. This account has been summarised by Baer (1927, 180) who assigned the species to *Oochoristica,* a genus which he placed in the Anoplocephalidae, Linstowinae. Beddard (1914) and Baylis (1919) have emphasised the close relationship existing between the genus and *Linstowia,* though the latter author thought that both genera belonged rather to the Dilepinidae than to the Anoplocephalidae, and should be included in the same subfamily.

This parasite has been collected on several occasions from *T. rugosus* in South Australia where it is common, and occasionally in the drier parts of New South Wales, Victoria and Southern Queensland. Sometimes the worms were present in such numbers as to fill the lumen of the intestine. Since the original description is incomplete, it may be supplemented.

The largest worm measured 220 mm. in length, but most were between 100 and 150 mm. The short neck was 0·3 to 0·5 mm. long by 0·4 mm. wide, being as wide as, or slightly wider, than the scolex. The width is about 0·55 mm. at 1·5 mm. behind the head, while at 7·5 mm. from the scolex segments are 0·5 to 0·6 mm. long by 0·63 to 0·65 mm. broad, and have the sex organs, other than the genital cloaca, developed. At 15 mm. they measure 1·1 mm. long by 0·65 mm. broad, and the cirrus sac is more elongate, and the genital pore open. Proglottids at full sexual maturity are about 1·5 mm. long by 0·9 mm. broad. Some very long segments, 4·4 mm. by 1 mm. broad, were observed and these contained eggs, testes, well-marked sex ducts and remnants of the ovary and yolk glands. An intercalary segment was noticed extending about two-thirds of the distance across the strobila. There is no overlapping and there is only a slight indentation laterally at the junction of segments, so that the margin of the strobila is practically straight and the form of each segment is rectangular with slightly rounded corners.

The scolex is scarcely marked off from the neck. It is rounded in front and measures 0·2 to 0·25 mm. in length by 0·32 to 0·35 mm. in breadth. MacCallum's

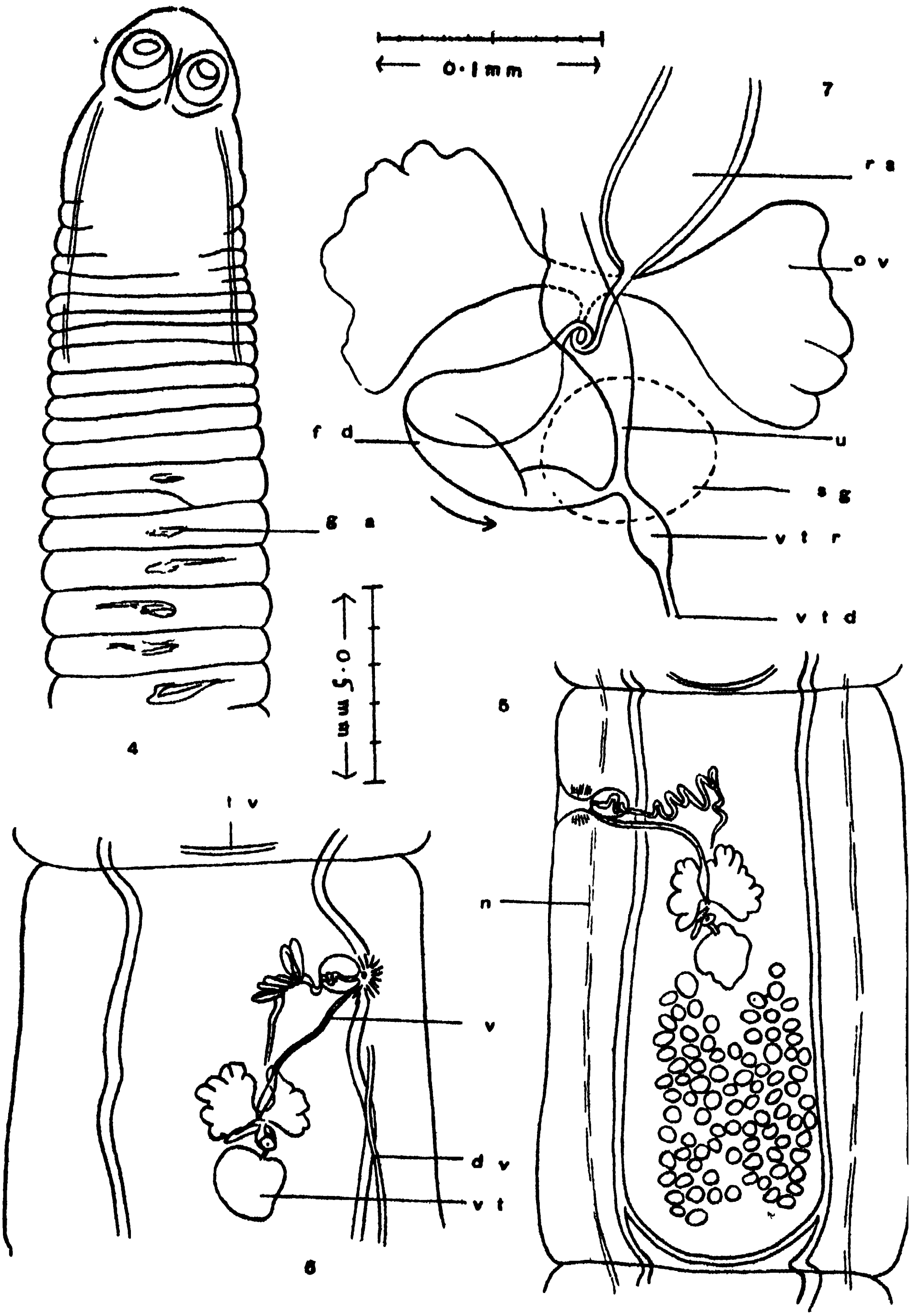


Fig. 4-7 *Oochoristica trachysauri*. Fig. 4, anterior part of strobila; 5, sexually mature segment; 6, portion of segment without common genital pore but with atrium near ventral excretory canal. Figs. 4-6 drawn to same scale. 7, female complex, drawn to scale indicated above it. d v, dorsal excretory canal; f d, fertilising duct; g a, genital anlage; n, longitudinal nerve; o v, ovary; p m s, posterior margin of segment; r s, receptaculum seminis; s g, shell gland; t v, transverse excretory canal; u, uterus; v, vagina; v t, vitelline gland; v t d, vitelline duct; v t r, vitelline reservoir; v v, ventral excretory canal.

figure indicates a triangular rostellum or proboscis which was not observed in the present material. The suckers are relatively large, and almost circular, 0·12 mm. across by 0·13 mm. in depth, their aperture directed forwards. They are muscular and very mobile in life. There is a furrow between the suckers. Calcareous corpuscles are few except in young segments and are usually round (0·007 to 0·015 mm. in diameter). The lateral longitudinal nerves in sexually mature proglottids lie at about one-sixth, or one-seventh, of the segment width from the corresponding margin.

The excretory system possesses the usual ventral and dorsal canals, the latter about half the diameter of the former, except in the scolex where they are approximately equal. The two canals of the same side join to form a loop in front of the suckers and just laterally from the rostellar plug, the loops of opposite sides being connected by a tube of similar calibre.. The longitudinal canals become sinuous in the neck. In the segments the dorsal vessel is more wavy than the ventral and usually lies on the outer side of, or above, it. Both are displaced in the region of the sex ducts which pass between them. The ventral canals are connected by transverse vessels which do not originate close to the posterior margin of the corresponding segment, but at a considerable distance in front of it, then bending back almost to the rear border of the segment, so that there is a marked curve in their course. The ventral canals are sharply bent inwards at the posterior edge of the proglottis. Many anomalies regarding the transverse canals were noted, and there may be one or more supplementary canals given off near the posterior corners, and these may end blindly or they may junction with each other or with the main transverse vessel, or there may be two transverse canals (fig. 8). Baylis (1919) refers to certain peculiarities regarding the transverse canals of *O. zonuri* and *O. agamae*. Zschokke has also referred to a somewhat similar condition in *O. rostellata*. It does not occur in *O. truncata*.

The genital cloaca alternates irregularly and lies at about the junction of the first and second quarters of the margin of each segment and is not marked by any obvious prominence. It is fairly wide and deep and surrounded by powerful radiating and sphincter muscle fibres. The sex apertures are close to each other, the female pore being postero-ventral, or directly ventral from the male. In one segment there was no common genital pore to the exterior, the sex ducts terminating in an atrium immediately inwardly from the excreting canals (fig. 6).

The separate testes are recognisable in segments 5 mm. from the anterior end, as also are the rudiments of the ovary and vitellarium, while a mass of more deeply staining tissue indicates the positions of the developing sex ducts. As segments become older this mass extends laterally towards the pore-bearing margin. Between 7 and 8 mm. distance from the scolex, the ovary, shell gland and yolk gland, and also the inner parts of the vas and vagina, are now recognisable, though the latter ducts are not yet tubular. At 15 mm. the cirrus sac is elongate and the genital pore open. Sperms were present in the seminal vesicle and receptacle at 2·5 mm. from the scolex.

Testes are much more numerous than MacCallum indicates, and are not distributed in two groups, as he figured them. There are 65 to over 80 arranged behind the level of the ovary and may extend further forward than the yolk gland, there being a small area behind the latter free from them. They extend from the excretory canals of one side to those of the opposite margin, but do not reach the posterior end of the segment. They are about 0·06 mm. in diameter, but may be 0·045 to 0·07 by 0·06 to 0·08 mm. The vas deferens travels forwards as a narrow tube parallel to and near the ootyp and receptaculum, crossing over the ovary near its bridge and rather nearer the midline than the female ducts. It becomes thrown into a number of short loops in front of the level of the cirrus sac and inwardly from the excretory canals. This vesicula seminalis, which has

thickened walls, crosses above the vagina, or may pass outwards in front of it, to enter the cirrus sac within which it becomes thin-walled and thrown into a series of folds or loops when the cirrus is retracted. The latter measures 0·12 mm. long by 0·025 to 0·035 mm. wide. Surrounding the vesicula in the vicinity of the excretory canals are large cells, probably prostate. Self-fertilisation was observed in one segment, the cirrus being bent round to be inserted into the vagina lying directly below the sac and a mass of sperms was present in the outer part of the female duct. The cirrus sac is rounded, 0·1 to 0·14 mm. long by 0·08 to 0·01 mm. in greatest width. When the penis is retracted the sac does not extend inwards as far as the ventral excretory canal, though it may reach the

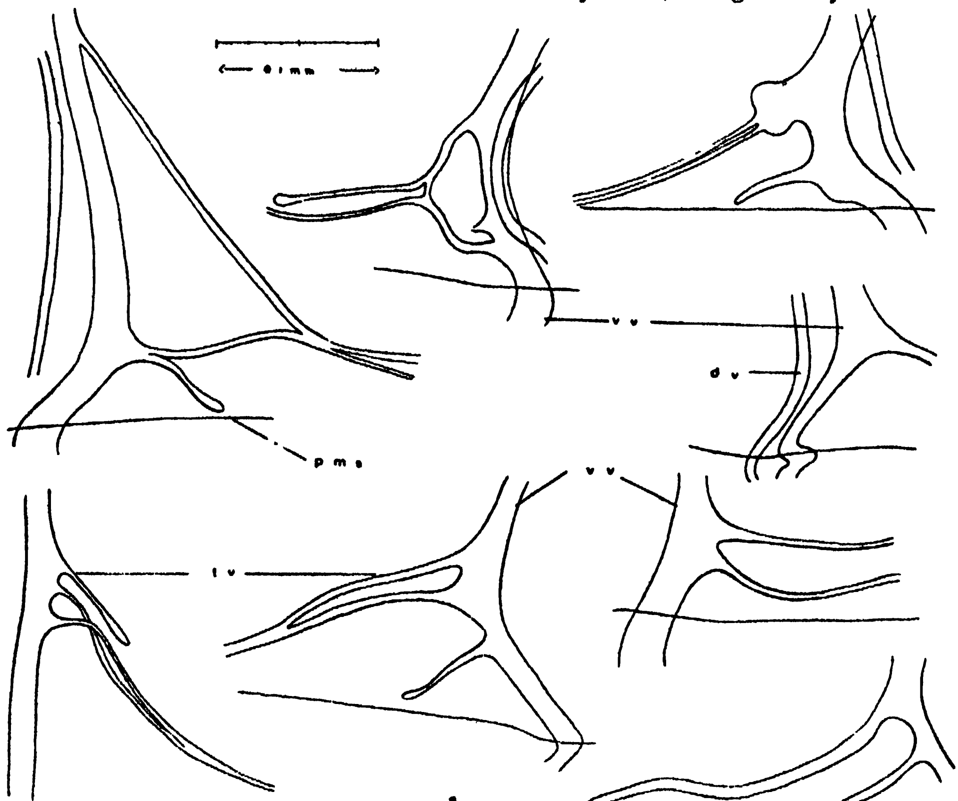


Fig. 8.

Fig 8, *Oochoristica trachysauri.* Series of camera lucida drawings to illustrate variability of the transverse excretory canal system. Lettering as in preceding figures.

dorsal. It generally lies just in front, parallel to and on a higher dorsal level than the vagina, and also above the longitudinal nerve.

The ovarian wings are connected by a very narrow bridge and are themselves slightly lobed. In mature segments with a developing uterine reticulum, the organ may measure 0·25 mm. across and 0·13 to 0·17 mm. long. The wings extend dorsally and may not be quite symmetrical, the inner being slightly longer. There is a short oviduct from the middle of the bridge passing backwards and becoming curved to join the wide fertilising duct between the ovarian lobes.

The vagina travels inwardly from the female pore directly below the outer portion of the cirrus sac and then above the ventral excretory canal, becoming a

narrow tube which eventually widens into a long fusiform or pyriform receptaculum, the form depending on the sperm content. The narrow end is directed anteriorly, while from the broader posterior end which abuts on the ovarian bridge, there issues a very narrow duct crossing above the ovary and then bending ventrally to enter the widened fertilising duct. The latter is thrown into a few wider overlapping loops extending behind and below the shell gland and then becomes suddenly narrowed, receives the vitelline duct and enters the shell gland from below. It then travels anteriorly in a sinuous curve as a narrow uterine duct, above the fertilising duct and ovarian bridge. It may be above the receptaculum, or between it and the vas deferens. It now divides up into a loosely branching reticulum in which the eggs come to lie singly in capsules. These rounded capsules, which measure 5 to 6 μ by 3·5 to 4·5 μ, occupy a large part of each ripe segment and occur laterally above the ventral excretory canals. Eggs are 3·7 to 4·2 μ by about 3 μ, generally 4 by 3 μ, and were present in two-thirds of the length of a strobila of 150 mm. The embryo is almost round and measures 2·5 to 3 μ.

The shell gland is rounded to elliptical, 0·08 to 0·15 mm. across, and lies immediately in front of the vitellarium. The latter is 0·12 to 0·15 mm. wide, and 0·16 to 0·18 mm. long. Its short duct arises from near the anterior end and joins the fertilising duct immediately before penetrating the shell gland from below. The form of the yolk duct and ootyp varies according to the degree of elongation of the segment. There may be a small yolk reservoir.

Meggitt (1920) and Baer (1927) have published keys to the species of the genus *Oochoristica*. According to that given by the former, *O. trachysauri* would be near *O. agamae* and *O. wagneri*, more particularly the latter, because of the very large number of testes. If Baer's key be followed, then the species would fall near *O. zonuri*.

Nematoda.

Veversia tuberculata (Linstow) Thapar.

In 1904 Linstow briefly described *Oxyuris tuberculata* from *Trachysaurus*. Subsequently Thapar (1925, 114-7) erected a new genus, *Veversia,* for its reception and gave additional information and figures regarding it, his figures being reproduced by Yorke and Maplestone (1926, 201-2). This parasite is rather common in the rectum of the lizard, and I have seen specimens from localities in South Australia, Victoria, New South Wales and Southern Queensland.

Oxyuris (sensu lato), sp., Thapar.

Thapar (1925, 130-2) gave an account of an Oxyurid of which only females were present. The species was regarded as being near, but distinct from, the genera *Pharyngodon* and *Thelandros*, from both of which the anterior position of the vulva excludes it. The genus *Oxyuris* is now restricted to species resembling *O. equi,* but Thapar's account shows that this form is closely related. No locality is mentioned.

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THE GEOLOGY OF THE EASTERN MACDONNELL RANGES, CENTRAL AUSTRALIA.

By C. T. MADIGAN, M.A., B.E., F.G.S.

[Read August 11, 1932.]

PLATES III. TO V.

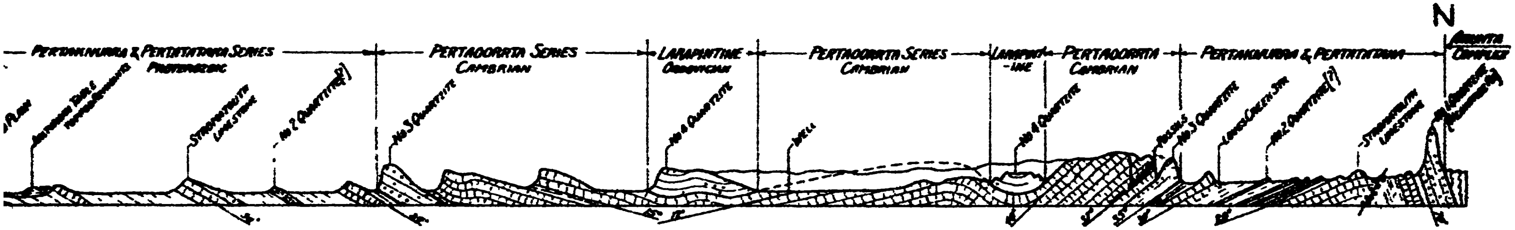
CONTENTS.

I. INTRODUCTION.

Papers entitled "The Geology of the Western MacDonnell Ranges" (1) and "The Physiography of the Western MacDonnell Ranges" (2), by the present author, described the MacDonnell Ranges to the west of the overland telegraph line, that is, west of the longitude of Alice Springs. The work of earlier geologists was outlined, and as the result of three expeditions into the area the author was able to bring to finality the broader features of the geology, with map and sections.

It was recognised that the key to the geology of Central Australia lay in the regular and unrepeated parallel outcrops which make up the ranges to the west, and the Ellery Creek section was measured as a type section of the different beds. The formations to the west were subdivided into series as follows:—

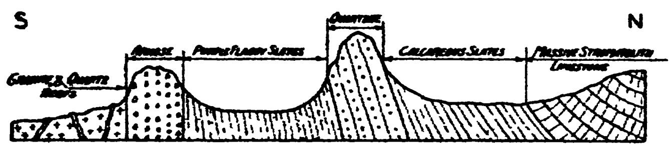
The Arunta Complex, consisting of schists, gneisses, and intrusive rocks, all highly altered, and comprising the northern half of the western MacDonnell Ranges, forms the basement rocks. The succeeding and overlying formations lie almost entirely along the southern margin of the ranges, and are nowhere to the west known to be invaded by igneous intrusions.



SECTION DOWN RIVER ROSS FROM LOVES CREEK TO TODD PLAIN, 14 MILES

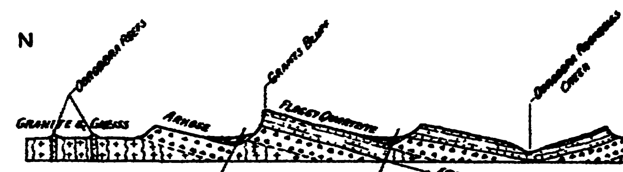
HOR SCALE — 0 1 2 3 4 5 6 7 8 9 1 2 MILES VERT SCALE 0 500 1000 FEET

FIG I



N-S. SKETCH SECTION OF BASE OF PERTAKNURRA SERIES, 3 MILES WEST OF GRANTS BLUFF HOR SCALE 0 50 100 200 YARDS

FIG II



N-S SKETCH SECTION ACROSS JERVOIS RA. AT GRANTS BLUFF, 2 MILES.

HOR SCALE 0 ½ 1 MILE

FIG III

Immediately overlying the Arunta Complex is the Pertaknurra Series, mainly massive stromatolith limestones, introduced by the Heavitree quartzite, known as No. 1 Quartzite, which forms the main and most imposing ridge of the western ranges. This quartzite was shown to form two ranges, the Heavitree, and the Chewings Range to the north of it, the ranges being the two limbs of the Alice Anticline, in the eroded crest of which Alice Springs lies. No repetition of the massive limestones, however, was found to occur with the quartzite in the northern limb of the fold, the quartzite being everywhere embedded in gneiss, mainly granitic gneiss. It was suggested that the Heavitree quartzite was separated from the following limestones by a disconformity. The Chewings Range disappears a few miles west of the telegraph line, along which there is nothing but gneissic granite, once the Heavitree Gap in the quartzite, on the southern margin of the ranges, is passed through, till the rock exposures give out in the Burt Plain, fourteen miles to the north. The Arunta Complex was considered to form a great stable shield to the north and north-west of Alice Springs, with probably no repetition of the younger beds, particularly the massive limestones, in those directions.

The Pertaknurra Series is separated to the west from the Pertatataka by a conglomerate containing boulders of the Pertaknurra, and referred to as No. 2 Quartzite. The Pertatataka there consists of this conglomerate, followed by red and purple slates, quartzite, and oolitic and stromatolith limestones, and passes without apparent unconformity into the Pertaoorrta, the base of which series is a very characteristic and persistent range of dark red quartzite, the No. 3 Quartzite.

The Pertaoorrta consists of quartzites, purple slates, and stromatolith limestones, in which no fossils were found, apart from the prolific and varied stromatolith forms. The Pertaoorrta, being definitely Pre-Ordovician, was tentatively placed in the Cambrian, on lithological similarity with the Cambrian of the Flinders Ranges and southern South Australia, and the Pertaknurra and Pertaoorrta were referred to the Proterozoic, in the sense of late Pre-Cambrian, without prejudice as to whether this division be considered as the lowest division of the Palaeozoic, or as Pre-Palaeozoic.

Above the Pertaoorrta comes the Larapintine, with an abundant Ordovician fauna, and finally the great Post-Ordovician conglomerate, the Pertnjara Series, referred to the Permo-Carboniferous.

The Ellery Creek section showed a thickness of nearly 25,000 feet of sediments overlying the Arunta Complex, divided into the above series, and occurring in regular sequence as east and west ridges southward from the Heavitree Range.

The basal beds of the Larapintine are known as No. 4 Quartzite, and each of these four quartzites forms conspicuous and almost continuous ridges or ranges to the west of the telegraph line.

The James Ranges, west of the Finke, were shown as entirely composed of Larapintine formations, but eastward from that river the eroded crest of an anticline exposed the underlying limestones of the Pertaoorrta, extending to Deep Well on the telegraph line; and there were also extensive exposures of the Pertaoorrta in the centre of the Waterhouse Range.

The characteristics of the various series were found to be quite distinct and, armed with this knowledge, the author was in a strong position to tackle the more disturbed and little-known area to the east of the telegraph line. There remained still the possibility that more fossil horizons might be found in such a great thickness of supposed Cambrian formations, and the non-repetition of the younger sediments on the north flanks of the ranges

was still open to doubt. No attempt had so far been made to assign any of the formations to the east to any particular geological horizon, and it was also of interest to investigate the old goldfields in the light of further knowledge of the geology of the country.

Thus, through the kindness of the Council of the University of Adelaide in granting seven weeks' leave of absence, and with the financial assistance of the Commonwealth Council for Scientific and Industrial Research, the author was enabled to spend six weeks in the field out from Alice Springs in May and June of 1931. He was accompanied by Mr. S. J. O'Grady, one-time manager of the State Battery and Cyanide Plant at Arltunga, a very helpful and pleasant companion on a long trek; and he was further assisted by the loan, through the Commonwealth Government, of six camels, equipment, and black boy, from the police at Alice Springs.

II. Previous Geological Work in the Area.

While considerable work has been done in the Western Ranges before the present author came into the field, notably by the Horn Expedition, Dr. Chewings, and Mr. H. Y. L. Brown, yet the Eastern Ranges, in spite of the occurrence of gold, mica, and so-called "rubies" there, had been almost entirely neglected, except for the late H. Y. L. Brown, who made several reports in his capacity as South Australian Government Geologist when the Northern Territory was a province of South Australia.

The only published report, besides those of Brown, is a short paper by N. B. Tindale (3) reporting the discovery of Ordovician fossils near MacDonald Downs in 1931. Chewings makes several references to the eastern ranges in his papers on the western ranges, notably in his "Further Notes on the Stratigraphy of Central Australia," 1928 (4), and also in his delineation of the Pre-Cambrian Plateau, 1931 (5).

Davidson (6) prospected the country to the north of the area herein dealt with, and delineated the boundaries of some of the possible metalliferous country. His work lay in the shield of Arunta Complex, with its thin covering to the north of slates and quartzites of uncertain age, referred to generally as Cambro-Ordovician. His is a valuable mining report, but does not attempt to deal with stratigraphical succession.

No geological investigations have been made in Central Australia to the east of the area of the map published herewith, or to the south of it and east of the telegraph line, beyond the author's aerial observations in 1929 (12).

H. Y. L. Brown published five reports in connection with the country under review, after visits of inspection to the mining fields. The first two, in 1889 (7) and 1890 (8), were reconnaissance reports. The third, Reports on Arltunga Goldfield, etc., 1896 (9), was much the most important from a geological point of view, and includes all Brown's geological observations in the area, apart from mere reports on mines. A geological map covering almost the same area as that now presented, was produced. The rocks were placed in three divisions—Metamorphic and Igneous (Archaean?), corresponding to the present Arunta Complex; Primary, which includes all the present Pertaknurra, Pertatataka, Pertaoorrta and Larapintine; and Recent and Tertiary. The areas occupied by these three divisions were shown in colour on the map. Brown found no fossils in the area, and made no attempt at any further subdivision, which was only to be expected, considering that it was a pioneer effort in a large and almost unexplored region. The map and notes were of considerable use to the present author in deciding on routes. The topographical detail of the sketch map was obviously obtained from Winnecke's maps. The same report also includes

a map of an area north-east of Barrow Creek, and south-east of the Murchison Ranges, later dealt with by Davidson (6), and lying to the north of the present map, and also of an area in the neighbourhood of Hann's Ridge, on the telegraph line south of Barrow Creek, and a sketch section along the telegraph line from Barrow Creek to Oodnadatta.

The last two papers, on the White Range Gold Mines, 1902 (10), and Gold Discoveries near Winnecke's Depot and Mines on the Arltunga Goldfields, 1903 (11), are reports on the mine workings, and contain little of geological interest. The latter contains a good topographical map from Oodnadatta to the goldfields, intended as a route map before the days of the railway.

The present author's previous knowledge of the area was only such as was gained in the aerial reconnaissance in 1929 (12), on the eastern flight from Alice Springs to Lake Caroline, towards the Queensland border. The route lay along the southern margin of the ranges, and little was gained beyond the lie of the ranges to the south, and some dip directions.

III. The Present Expedition. Narrative.

The author set out with the main idea of making a section across the Eastern MacDonnell Ranges, visiting the old goldfields and the "ruby" and mica fields, and, if possible, getting as far as the Jervois Range, or, at any rate, well beyond the MacDonnells to the north-east, in order to study the formations on the north side of the ranges, about which information was very meagre and indefinite.

The first objective was Love's Creek Station, with a view to a section down the Ross River to the plains of the Todd. The motor track was followed along the Heavitree Range on its north side to Undoolya Gap (where the author made a lucky forced aeroplane landing in very rough country in 1929), thence through the Gap and along the south side of the range, which turns north-east after a few miles. The track on the south of the range or ridge lies in the Pertaknurra limestones, and abundant stromatoliths were found in the creek section on the north side of the track, the first creek before Williams Well.

From Williams Well the track runs north-east to Acacia Well, and then easterly to Love's Creek Station, with the dark red No. 3 Quartzite range, the base of the Pertaoorrta (Cambrian) on the right or southerly side all the way, and continuing on easterly far beyond Love's Creek. The dip of the beds has flattened out at Acacia Well, and the track has receded from the Heavitree Range (No. 1 Quartzite) which cannot be seen there. At Acacia Well the limestones on the northerly side of the track were again examined at Chewings' "Cryptozoön" locality.

The track from Undoolya Gap to Love's Creek Station lies in the valley between the Heavitree quartzite and No. 3 Quartzite, exactly corresponding stratigraphically to the Glen Helen Valley to the west, traversed by the author for ninety miles in 1930 (1). Plate III., Fig. 1, shows a view looking across the valley from the "Cryptozoön" limestones at Acacia Well to the Cambrian ranges on the other side.

The choice of the Ross River for a section proved a happy one, as Archaeocyathinae fossils were found in the Pertaoorrta limestones in the Ross Gorge, only 900 yards down the gorge from the station, which stands at the entrance to the gorge. The fossils are found on the right bank of the stream, in the steep cliff face at a waterhole in the sandy bed. The stream is called Love's Creek from Mt. Benstead to the station, and Ross River from the station to its junction with the Todd.

The No. 1 Quartzite range was climbed at Love's Creek, but the view to the north is obscured by a repetition of the same formation.

From Love's Creek Station the journey was continued along the motor track through Bitter Springs. The formations are very disturbed for the five miles in the neighbourhood of Bitter Springs, between Love's Creek to the south and Paddy's Hole Plain to the north.

"Bitter Springs" is a sandy bend in the small stream which the track follows up through the ranges, where soakage water may be obtained in the sand close to the surface, or may even be found without digging. The locality is in disturbed dolomitic limestone, and the water is unpleasant to taste, though a Heaven-sent draught in time of need, like most of the Central Australian waters.

Dolomitic limestone and great masses of Heavitree quartzite, the Pertaknurra formations, hem in the Bitter Springs gorge. At the northern end of the gorge a low anticline in the quartzite is crossed, and one passes out into low rises of gneiss and schist as the track turns easterly, the first Arunta Complex rock met since leaving Undoolya Gap. The low hills soon give way to a plain, the Paddy's Hole Plain, bordered by quartzite ranges to the north and south. The southern range, of Heavitree quartzite, was ascended at a wide gap, where the range rose 600 feet above the plain. This range continues eastward to form White Range.

Casts of large Osmundaceous plant stems had long been known from Paddy's Hole Plain. Mr. O'Grady, the discoverer, when in charge of the Arltunga battery, with Mr. Cavanagh, the present owner of Ambalindum Station, collected a quantity of these interesting forms in a dray, since when Mr. Cavanagh has been giving them away to visitors and passers-by. It was hoped that Mr. O'Grady would be able to re-locate the spot, which was somewhere near the camp site shown on the accompanying map. Between the camp and the range to the south there were several low, flat-topped hills rising to 50 feet above the plain, and capped by porcelainized Planorbis limestone. These are of late Tertiary or Pleistocene age. The exact spot where the fossilized ferns were found could not be definitely determined, and no more such forms were discovered.

The plain was crossed diagonally towards Mt. Gordon, which is near the eastern extremity of the quartzite ranges to the north of the plain, the Mt. Laughlen—Mt. Gordon Range. The old Arltunga battery lies at the foot of Mt. Gordon, and is the centre of the old mining district. An ancient miner, a newcomer, was treating a dump of fine slimes, with the assistance of natives, and another, the last of the thousand men who were there twenty years ago, was merely existing at the "Cross Roads," some two miles away, and awaiting, he said, the same end as was met by all who stayed there more than a couple of years—death as the result of swallowing quartz dust. The policeman, the third inhabitant, was away on leave. The battery buildings, the police station, the last miner's hut, and the neglected graves, of which fifteen were seen, were all that remained of the thousand men and their habitations, the "pubs" and the stores, the racecourses and the sports meetings of happier times. The countryside has returned to primeval bush. The battery opened in 1898, and closed in 1913.

The old workings at White Range were examined, and from White Range a course was taken to Ambalindum Station, through the rough gneissic hills to the east of Mt. Gordon, out on to the Hale Plains.

There are good wells at the Arltunga battery (called Star of the North Well), at the police station a mile to the south-east, at the Cross Roads, another mile east, and at the original Paddy's Hole or Arltunga Well, two

miles south-south-west of the Cross Roads. These positions are shown on the accompanying map.

Brown mentions (H. Y. L. Brown, 1902, p. 6) that a seam of lignite some twelve feet thick had been found in well-sinking on the alluvial flats of the Hale River. This report was made by H. B. Corbin, manager of the Arltunga battery, to the Minister for the Northern Territory in 1902. Corbin inspected the well, and took and forwarded samples of the coal, which was found to be highly pyritic lignite. The 12-foot seam was entered at 26 feet from the surface, with carbonaceous clay below it. Above lay gravelly clay. This particular well, according to Mr. Cavanagh of Ambalindum Station, is the single isolated locality for lignite known in Central Australia. Great hopes were entertained of examining further into these interesting deposits, and the well was visited. It is on the south bank of the Hale, five miles west of Ambalindum Station, and opposite the well and windmill shown by a circle on the map between the Garden and Ambalindum Stations. There are again Tertiary or Quaternary formations here, referred to later as Arltungan, in the form of low, flat-topped rises of bluish clay full of boulders, with porcelainized cappings, rising to thirty feet above the plain. They are an old alluvium. The well is at the foot of one of these remnants, and is no longer used, though a dilapidated windlass remains. The well is timbered for the first twenty feet or so. Below the timber, boulders could be seen projecting from a clay matrix, and then water. There was nothing remaining of the spoil heaps from the excavation, and no signs of lignite. There have been no reports of lignite from any of the other wells on the Hale flats.

After the unsuccessful search for lignite, a return down the Hale to Claraville Station was made, travelling in the rough foothills north of the river for the latter part of the distance. These hills were also flat-topped and heavily porcelainized, with several feet of pure white chalcedony capping some of them.

From Claraville it was desired to cross the Hart's Ranges and visit the mica fields in the neighbourhood of Mt. Palmer. The Hart's Ranges are very rugged and rough, and not easy going for camels, in places. It was difficult to get any advice locally, for, though the bushman knows his own way about, he is as a rule a very poor hand at explaining a route to anyone else. It was finally decided to pick one's own track, and the route followed is marked on the map. A motor track goes up the Tug and round Mt. Campbell to the north front of the ranges; and another, the Queensland, or Lake Nash, road, eastward round the east flank of the Hart's Ranges. Either the Florence or the Lizzie may be followed up through the ranges by horse or camel, but a vehicle could not get through.

The "ruby" sands were first seen in the Florence, whose sands are red with small garnets. The motor track was unexpectedly met near the Lizzie, but was again left where it crossed that stream in order to run the Lizzie up. The Lizzie above the road crossing flows through garnetiferous gneiss, and the sands are half garnet.

This stream ran out at a narrow divide, as shown on the map, and the northern watershed was entered, well south of the latitude of Mt. Brassey. A rough, steep creek led down into an easterly-flowing watercourse, which has been taken for the headwaters of the Entia Creek. Very rough and dissected gneissic country separates this creek from the plains to the north. It was a slow journey from the waterhole marked on the map, round to the east side of Mt. Palmer. Mt. Palmer was ascended, and the mica "shows" in the vicinity inspected. A party of Italians had just re-started operations

on the old "Disputed" claim, and work had recently been in hand on the west side of Mt. Palmer, on the "Oolgarinna" claims.

A fair camel pad leads out from the east side of Mt. Palmer northward to the plain at Barclay's "Marked Tree," where a motor track runs along the front of the ranges, used by the mica miners, who have operated almost all along the northern face of the ranges, at one time or another, though only two parties, both of Italians, were then in the field.

Luce's Spring, situated a mile up a steep gorge, is really, like so many so-called springs, a soakage, a sand-filled hollow in the rock floor of the gorge, containing water. Cattle from the plains go up to water there, and in dry times the water is somewhat foul, as the cattle congregate on the sand in the narrow space.

The motor track fades out easterly along the front of Hart's Range, so a course was set for the Plenty Wells, across well-timbered red loam flats. Several Arltungan flat-topped hills occur on the Plenty plain, one of which, lying two miles south of the Plenty Wells, was visited and examined.

The Plenty was named by Barclay (13), who found that its broad, sandy bed, a quarter of a mile wide in most places, was a veritable underground river, where water could be obtained at a few feet below the surface. The surface is usually bone dry, and glistening white and hot in the sun, but on a few scoops of the shovel abundant clear water fills the excavation, and the yellow fluid from Luce's Spring is immediately discarded. The river bed is shallow, and the rock bottom close. Gneiss may be seen outcropping low on the banks. The owners of Huckitta Station have recently been employing scoops to make permanent dams. The dam is filled before the excavation is completed. A party of half-castes and natives were seen at work, the horses wading through several feet of water to drag the scoop through. There is one such dam at the Plenty Wells, one seven miles upstream, and another on the Entia Creek. A heavy rain, of course, obliterates the dams. Plate V., Fig. 1 shows the scoop hole in the Entia Creek.

A course for Mt. Sainthill was taken from Plenty Wells over low-lying country with scattered ridges of gneiss. A deep creek is met with, three miles westerly of the Marshall. This creek runs out of the Mopunga Range, and maintains a course parallel to the Marshall. Beyond the Marshall a motor track was met, which turns off the Lake Nash road for Huckitta Station. The objective was then Oorobbra Rockholes; but it was not known that the Lake Nash road passes the Rockholes, which were eventually come upon from the west side.

Mt. Sainthill is the last peak on a ridge running west from Oorobbra Rockholes, and then curving south, formed of the same arkose as the Rockholes formation. Brown gives a brief description of these interesting rockholes. They lie in the bed of a stream; in fact, they form the head of the stream, which has its origin in a basin about a mile square in the form of a shallow syncline in granitic arkose, with the string of rockholes running east-south-east down the centre. The Lake Nash road crosses the east end of the string of rockholes. The narrow gorge can only be traversed on foot. The deepest and most permanent waterhole is at the top of the western end, shown in Plate V., Fig. 2.

Grant's Bluff, named by Brown, is at the western extremity of the Jervois Range, and a mile from the Rockholes. The Lake Nash road passes between the Rockholes and the Bluff. It was hoped to visit the silver-lead-copper deposits recently discovered at the east end of the Jervois Range, but time was not available, as only ten days remained, which would necessitate

fast travelling on the return to Alice Springs, with the tableland to the north and the Winnecke mines still to visit.

From the top of Grant's Bluff, about 300 feet above the general level, perfectly flat-topped tableland could be seen to the north and north-west, extending as far as the eye could see westerly, with another patch to the north-east. It was particularly desirable to investigate this formation, and to get it stratigraphically placed; so a course was set westerly from the Rockholes along the southern margin of the limestone hills bordering the tableland, to the Marshall River, and thence northerly through the limestone to Huckitta Station, which lies under the edge of the tableland. As anticipated, the tableland was found to be of gently-dipping Larapintine beds, highly fossiliferous, but of quartzite, with the fossils poorly preserved.

From Huckitta Station a course was taken for the front of the Hart's Range, on the return journey. The Mopunga Range was passed through, and the complete series of Central Australian formations was recognised in the ten miles from Huckitta to the southern margin of the Mopunga Range, with the exception of the post-Ordovician conglomerate. This section corresponds to any section from the Heavitree Range to the south, along the southern margin of the MacDonnell Ranges, particularly to the west of the telegraph line. This discovery made a very satisfactory termination to the outward journey. Just what was wanted was revealed at the turning point, and hearts were brave again, and arms were strong for the quick return journey, in spite of cold and miserable weather, with rain, and attacks of diarrhoea.

Good fortune had favoured the excursion. The Cambrian age of the Pertaoorta had been definitely established, and the formations to the south had been identified to the north, across the Archaean core of the ranges, establishing definite horizons there for the first time, and making the future extension of geological work in that direction a comparatively simple matter, as the geology of the Eastern MacDonnells was now on a firm basis.

The scooping party was met, on the return, near the confluence of the Entia and Plenty. Another scoop hole was passed in the Entia, which creek was there as broad as the Plenty. The northern front of the Hart's Ranges was again traversed. The many pegmatite veins intersecting the gneiss show out plainly as white lines crossing the rugged scarps of the range. Mica workings occur all along the front. Stone's mica mine, five miles west of the Marked Tree, was visited.

A call was made at Mt. Riddock Station, which lies well out from the ranges; and from there a very rough horse pad led up a gorge south of the station through the scarp of the range to Schaber's house, whence another pad, impassable to vehicles, runs in a south-westerly direction to the Garden Station on the Hale, thus crossing the Hart's Ranges. The motor track to Claraville, down the Tug, is crossed on the way.

The westerly portion of the track from Schaber's follows round a well-defined range on its south side, with more open country to the north. On turning southerly, the pad ascends a rough creek-bed to the top of the divide, which is only two miles from the Hale plain. This crossing of the Hart's Ranges revealed only varieties of gneiss, with the exception of a patch of very much altered Pertaknurra limestone on the fall to the Hale plain, which was the first definite proof of the inclusion of Pertaknurra beds in the gneiss.

The Hale was followed up to Winnecke's old depot site, at a sharp bend in a branch of the headwaters of this river. There is a waterhole here, empty at the time visited, but probably water is obtainable by sinking. For five

miles eastward of this point, Pertaknurra limestone was traversed, striking east and west. This exposure is assumed to be continuous southward to the Winnecke mines, and is so mapped.

It was hoped to strike across the Hale Valley to the Winnecke mines; and from Winnecke's Depot a south-westerly course was taken through rough granitic gneiss hills till the motor track, a very good one, from the Hale valley via Bald Hill to Alice Springs, was reached, in the dark. It was found necessary to go back two miles to find the mines, where several men were prospecting. The mines are close against the Bald Hill—Mt. Laughlen Range; and here, again, the Pertaknurra limestones were met with, dipping northward off the quartzite range.

The motor track was then followed back to Alice Springs. The country from Winnecke mines to the gap through the range, six miles to the west, lies entirely in granitic gneiss, with the quartzite range on the left. More limestone was seen right in the gap, where the range has suffered slight faulting and lateral displacement. This range is of Heavitree quartzite right to Bald Hill, which was as far as it was examined.

Inside the gap, the track continues in gneiss on the south side of the range to Bald Hill, where there are further gold workings, which were inspected. From Bald Hill the track goes two miles westward in gneissic country, and then enters the plains, where it turns south-west straight for Bond Springs. There the MacDonnell Ranges proper are again entered, through small hills of gneiss, which gives way to granite as the telegraph station is approached.

The Map.

IV. The Map and Topography.

As with the map of the western portion of the ranges, considerable trouble was taken over the map produced herewith. The basis of this map was the 16 miles to the inch official map of Central Australia, issued by the Department of the Interior, Canberra. The official map has been compiled mainly from the maps of Winnecke and Barclay. Barclay, for the South Australian Government (13), made the first official exploration into the area in 1878. He passed round the north end of the Strangways Range from Bond Springs, and sketched in the Plenty and the Marshall in the neighbourhood at Mt. Sainthill. Winnecke (14), an officer of the South Australian Survey Department, explored the country north-east from Alice Springs to the Herbert River in 1882. His work formed a periphery to the north of Barclay's journey. He also visited the Hale in the neighbourhood of Mt. Laughlen, and sketched in all the country west of Mt. Benstead. From the Herbert River his traverses extended westward to Tennant's Creek, and along the telegraph line from Tennant's Creek to Alice Springs. He published a map with Parliamentary Paper No. 121 of 1882, and also included all his work, as far as the area now under consideration was concerned, in the map accompanying the report of the Horn Expedition (15), and also in his own account of that expedition (16), though the Horn Expedition did not deal with this area.

These two explorers erected many cairns on prominent points, which are shown as triangles on the modern maps, and are generally referred to as "trig." stations; but enquiries at the South Australian Lands and Survey Department failed to discover any records of triangulation; and the journals of the explorers mention the erecting of cairns, but never their occupation as survey stations. Errors in the map positions of these so-called "trig." stations soon became apparent to the traveller, and the present author is convinced that they were never fixed by triangulation. All maps of Central Australia

are merely sketch maps, based on horse and camel traverses, apart from the work of the overland telegraph and railway survey.

Mr. M. A. Blain, a surveyor employed by the Administration at Alice Springs, kindly sent a copy of his field book of a chain and theodolite survey of the road from Alice Springs to Bitter Springs, which the author plotted out, ensuring the accuracy of that portion of the map at least, and providing a good check on the remainder of the author's camel traverse. Mr. Blain's round of angles from the Mt. Undoolya "trig" to the neighbouring "trig" points confirms the view that the "trigs" have never been occupied.

The present map was compiled from Winnecke's and Barclay's maps, the official 16-mile map, Mr. Blain's traverse, and the author's own camel traverse and aerial observations. Some alterations to the creeks, and the westerly extension of the Mopunga Range, were obtained from Tindale's sketch map (3) of the area round MacDonald Downs Station to Mt. Ultim. A number of features have been added to the map in the way of stations, wells and streams, mountains and ranges, with their accepted local names. Positions in the MacDonnell Ranges are now probably correct to within a mile or two, but the error will be greater towards the north-east. The chief discrepancies between the author's own observations and the existing maps concerned the Claraville—Mt. Palmer area, and the Marshall River. As regards Mt. Palmer—Claraville, there seems to be an error in latitude here. Unfortunately, the author did not set out prepared to observe for latitude. Although the going is rough through the Hart's Ranges from Claraville, it is not bad enough to account for an overestimate of six miles. The author travelled eleven miles up the Lizzie from the motor track, and was then only at the camp on the divide west of Mt. Muriel, five miles from the marked position of the motor track, which is placed rather further south than the camel traverse indicated. The camp referred to was later fixed by a bearing from Mt. Palmer. The eleven miles would place the motor track right down on the Hale. It took much longer to reach Mt. Palmer than was anticipated. The positions of Claraville and Mt. Brassey have been retained as given on the official 16-mile map. It is interesting to note that Brown gives the distance from Oolgarinna (on Mt. Palmer) to Claraville as 31 miles, agreeing with the author's estimate, against 24 miles as scaled off on the map.

The Entia Creek is an important stream. Brown followed it up to near Mt. Palmer, so its course is probably somewhat as now indicated. Sprigg's Camp, shown on all official maps, is indefinite. At the circle on the present map, east-south-east of Mt. Brassey, there is a permanent waterhole and remains of bough shelters, which is probably the place. No conspicuous peak could be identified as Mt. Brady.

The course of the Marshall has been somewhat altered from its position on previous maps. It flows round the eastern end of the Mopunga Range, a newly-mapped feature. Mt. Sainthill is not on its banks, but some three miles east. The Marshall rises at Mt. Ultim, where, according to Tindale, there is a divide. The streams from Pulpit Rock direction were definitely noted by him to join the Fraser Creek, and not to be the headwaters of the Marshall, as the maps had wrongly suggested. The Marshall is a narrow and deep stream, quite unlike the broad, flat Plenty. The unnamed stream from the Mopunga Range, which runs parallel with the Marshall, is similar.

The Hart's Ranges definitely end at Mt. Powell. The Fergusson Ranges run east, to and beyond the Giles, as do the ranges in the vicinity of Love's Creek; but there is little information about the country between the Giles and the Hale. It is by no means a flat plain, as aerial observations showed; but the ranges fade away towards the Hale, and the hills become more

scattered. The more conspicuous ridges and ranges south of the Todd and eastward to the Hale, were added from aerial sketches.

The borders of the mountains or hilly areas are conventionally marked in on the map. The continuous and conspicuous ranges are almost invariably of quartzite, and these are indicated by rows of dots when definitely known to be quartzite. As was pointed out in the case of the western map, Winnecke's maps are covered with hachuring, which only indicates the position of the hilly regions, and is misleading from some points of view, as the hachuring does not in any way show the trend of ranges. Brown's colours superimposed on Winnecke's hachuring in Brown's maps produce an incongruous result, unless the hachuring is neglected.

The author's route is shown by a fine dotted line, and the main motor tracks by a heavier dotted line. The heights, marked in feet, were taken at the camp sites indicated. They were obtained with great care, by aneroid, which was compared with the mercurial barometer at Alice Springs Telegraph Station on starting out and on return. All readings were taken at 9 a.m., noon, or 9 p.m., and heights determined by comparison with the Alice Springs readings, kindly supplied by the Commonwealth Meteorologist, and the use of the Smithsonian Institute tables. The height of the instrument at Alice Springs is 1,926 feet, determined by railway survey. Anomalies which occurred in the use of the aneroid in the author's journeys to the west were happily absent on this expedition. Stations which were re-occupied gave results agreeing within reasonable limits. The maximum error in heights would not exceed fifty feet, and at some camps where several days were spent, the heights will be correct to a few feet.

The Topography.

The Eastern MacDonnell Ranges include the Fergusson, Strangways, and Hart's Ranges, and they extend from Alice Springs in a north-easterly direction for a hundred miles. The narrowest part of the ranges is along the telegraph line, where they are only 14 miles across, but the width increases to 50 miles at the longitude of the Ross River, 40 miles to the east. The north-easterly extension of the MacDonnells, the Hart Ranges, tongue out to a point at Mt. Powell. The great Heavitree Range, well known along the telegraph line at Heavitree Gap, where it forms the southern front of the MacDonnells, runs eastward for eighteen miles, through Mt. Undoolya, and then turns north-east to Mt. Benstead. From Mt. Benstead there are two main virgations, one continuing on north-north-east through the Georgina Range to Mt. Laughlen, where it joins the more or less east-west range of Bald Hill-Mt. Laughlen-Mt. Gordon. Another virgation runs easterly from Mt. Benstead to the north end of Bitter Springs Gorge, where it forms an anticlinal fold, the northern limb of which continues east to link up with the White Range. The southern limb, with flat dip, forms the eastern side of Bitter Springs Gorge, and extends eastward as two parallel quartzite ranges, the more southerly range being the high red range running eastward beyond Love's Creek Station, and forming the northern side of the Love's Creek Valley in that direction. Inside and to the south of the curve of this range, Mt. Undoolya—Mt. Benstead—Love's Creek Station and eastward, lie the Fergusson Ranges, a series of more or less parallel east and west ridges, which fade out towards the Hale.

These virgations and duplications of the Heavitree Range form the most imposing ranges in this part of the MacDonnells. They are shown by dotted lines on the map. To the north and west of the great sweep Mt. Gillen—Mt. Undoolya—Mt. Benstead—Mt. Laughlen—Bald Hill the ranges are made up of rough, rounded hills of granitic and gneissic country.

The Strangways Ranges to the north of Bald Hill form a north-west bulge to the highlands. They are a westerly extension of the Hart's Ranges, and although not visited, they almost certainly are formed of gneiss, with possibly some cappings of Heavitree Range quartzite, continued on from the Bald Hill Range.

The Hale River rises in the Strangways Ranges, and flowing easterly, by its broad plain divides the eastern MacDonnells into two distinct units, connected to the west by the Strangways Ranges. To the north of the Hale there are no quartzite ranges, but an entire absence of the obvious trend lines of the main ridges to the south of this river. On the north side lie the Hart's Ranges, formed of ancient gneisses and schists, with intrusive rocks. The country rises gradually from the Hale through rough hills to the northern margin of the ranges, where an east-west line of peaks, including Mt. Campbell, Mt. Mabelle, Mt. Brassey and Mt. Palmer, marks their greatest elevation. These peaks are the highest in the eastern ranges, Mt. Palmer reaching 3,700 feet. Mt. Brassey is probably higher. The highest mountains in the MacDonnells are west of the telegraph line.

The highest part of the area of this map, apart from the mountain peaks, is in the neighbourhood of Bald Hill, in the Strangways Ranges. A camp on the plain to the west of Bald Hill was at 2,590 feet, and the general height in the Strangways Ranges is probably about 3,000 feet. There are no striking peaks in these ranges.

The Todd Plain stands at about 1,450 feet, and the Hale Plain at Ambalindum and Claraville at 1,950 feet. The Plenty at Plenty Wells is at the same level as the Todd at the Ross confluence—1,450 feet.

The main watershed divide runs from the northern margin of the ranges at Bond Springs, easterly to Randall's Peak, north to Bald Hill, and into the Strangways Ranges, and thence due east through the northern part of Hart's Ranges to Mt. Powell, their extremity. To the south of this line, the Todd, Ross, Giles, Hale, Illogwa and other unnamed streams all run south-easterly into the Simpson Desert, where they flood out, and are lost. The Plenty takes all the run-off from the north side of the Hart's Ranges, and flows east, either flooding out, or joining the Marshall, probably either, according to the rains. To the west of the Strangways Ranges the streams, the Six Mile, Harry, and Burt Creeks, flow west, and soon lose themselves in the Burt Plain. From the north of the Strangways Ranges, the run-off all goes to the Sandover River, which eventually collects all the drainage from the northern portion of the map, except for the Marshall, and floods out another hundred miles to the north-east, in plains. There is no definite termination to any of these streams. Like old soldiers, they gradually fade away.

The Plenty Plain separates the MacDonnell Ranges from the more hilly country to the north-east. South of the Plenty, to the Hart's Ranges, extends a very level, scrubby, red loam plain, with only a few low, flat-topped Arltungan remnants in the way of hills, but north of the river, low gneissic hills and scattered ranges break up the plain for the first twelve to fifteen miles, when the Mopunga Range is reached. This range consists of gently curving parallel ridges of arkose and quartzite, rising two or three hundred feet above the plain, separated by limestone valleys. The Marshall flows eastward along the north front of these ranges, in rough but low limestone country, turning south-east through a break in the range. The Mt. Sainthill arc and the Jervois Range are a continuation eastward of the Mopunga Range formations, which also extend westward to beyond MacDonald Downs Station. North of this line of hills lies a belt of limestone country five miles

wide, and then comes the scarp of the flat Ordovician tablelands. This scarp is 300 feet high at Huckitta, but Brown states that the total rise is from 600 to 800 feet near Mt. Ultim. It is only scaleable at occasional points. Brown relates his experiences in trying to get down from the tableland in the vicinity of Mt. Ultim, where he was confronted by precipices at every turn. He got rather bushed in his efforts, and named Mistake Creek in memory of his experience. His difficulties go far to explain why he failed to find the Ordovician fossils there. A height determined near Huckitta gave 1,550 feet, so that the height of the tableland is in the neighbourhood of 2,000 feet.

The Marshall runs eastward for 80 miles from Mt. Sainthill, where it joins the Hay, and flows southerly for almost another 200 miles to the Queensland border in the direction of Birdsville, where it floods out.

The north-west corner of the map is occupied by plains, with occasional scattered hills.

V. Stratigraphy and Lithology.

(a) Regional Distribution of the Formations. Map and Section.

The whole sequence of formations previously described by the author as occurring in the Western MacDonnells, with the exception of the post-Ordovician conglomerate, was recognised in the eastern ranges; and the areas occupied by the different series are shown on the accompanying map.

The geological map naturally divides itself into two portions—the MacDonnell and Hart's Ranges in the south, and the hilly area to the north-east; the two being separated by the Plenty Plain.

The ranges will be considered first.

The Archaean formations, the Arunta Complex, occupy the main portion of the mountainous region. These crystalline rocks, schists and gneisses, form almost the whole of the MacDonnell Ranges at their narrowest part, the telegraph line, where they are bordered to the south by the Heavitree Range of quartzite, and disappear to the north under the alluvial plains, which, incidentally, are not sandy. This strip widens as it extends north-easterly, forming the main MacDonnell Ranges; crosses the Hale River at its head-waters, and ends in the Hart's Ranges, which are almost entirely composed of these schists and gneisses, the exception being a few highly-altered patches of included younger formations.

The Heavitree quartzite is the dominant quartzite ridge throughout the ranges. From the Heavitree Gap it extends eastwards and northwards, still in general marking the southern extension of the Arunta crystalline rocks; but the investigations on this expedition clearly showed that this quartzite, together with portions of the still higher limestones, have been caught up in the later stages of the disturbances which the Arunta formations have undergone. A virgation of the Heavitree quartzite cuts right across the ranges from Mt. Benstead, through the Georgina Range and Mt. Laughlen to Bald Hill, and possibly beyond. Patches of highly altered Pertaknurra limestone, mentioned below, are found in this region; and there are probably other remnants of these limestones and of the Heavitree quartzite in the Eastern Ranges, but the chief ridges of the quartzite were noted, and are marked in on the map. No formations other than the Arunta were recognised in the Hart's Ranges; and their western extension, the Strangways Ranges, is probably all composed of Arunta Complex, with the exception of Heavitree quartzite at Bald Hill.

The Pertaknurra Series, of which the Heavitree quartzite is the base, forms a southern fringe to the shield of Arunta crystalline rocks. Between Heavitree Gap and Undoolya Gap exposures of the beds overlying the basal

quartzite are inconspicuous or absent, the plains coming right in to the quartzite range. This area was not examined in detail. On the western side of the telegraph line the whole series up to portion of the Larapintine is exposed, as dealt with in the author's paper on the Western Ranges. Ward's section (17) was made along the telegraph line.

From Mt. Undoolya eastward there are great exposures of the Pertaknurra limestones, which form rugged hills, as to the west. As the Heavitree Range curves north-eastward, the dip of the beds lessens, and the outcrop widens, till between Mt. Benstead and Acacia Well the Pertaknurra limestones and intercalated beds occupy a width of over four miles, the beds dipping at 17° at Acacia Well. In the neighbourhood of Bitter Springs the beds of the series are much disturbed and confused, as shown in Plate III., Fig. 2. The basal quartzite is no longer represented by a single ridge, but by several ridges, with faulting and folding. The southernmost of these ridges runs eastward from Bitter Springs, in a high, red range, forming the northern side of the Love's Creek Station plain. South of this range the beds show an orderly sequence of outcrop, exactly as they do all along the Heavitree Range to the west of the Heavitree Gap, for a hundred miles. At Love's Creek Station the range, which may still be called the Heavitree Range, is backed up by rugged limestone hills, crowded with algal remains. These hills soon give way to a plain in softer beds, the south side of which is formed by the No. 3 Quartzite range, the base of the Pertaoorrta (Cambrian). The valley here is the exact counterpart of the Glen Helen Valley to the west.

To the north of the Love's Creek valley and Heavitree Range, the formations are much more disturbed, there being three quartzite ridges, the most northerly forming the southern margin of the Paddy's Hole Plain. These ridges are embedded in Arunta Complex to the east of the Bitter Springs Gorge, as far as could be ascertained from a view from the summits of the southern and northern ridges; but only the gorge was traversed, where quartzite forms the eastern side, and much-contorted limestone and slates the western. At the north end of the Bitter Springs Gorge an anticline in the Heavitree quartzite is crossed, and the quartzite is seen from a high vantage point to be a continuous ridge from Mt. Benstead, and to continue on, on the north side of Paddy's Hole Plain, to Mt. Gordon. Another range of the same quartzite forms the southern boundary of Paddy's Hole Plain, running eastward from the north end of the Bitter Springs Gorge, then curving northward to form the White Range, then turning eastward again to the Hale River and beyond. Ruby Gap in the Hale River is probably through this range.

From the north of Paddy's Hole Plain to the Hale River, and in the Georgina Range, and at Mt. Laughlen, the dip of the quartzite is small and undulating. The overlying beds have been eroded away. The triangular area between Mt. Benstead, Mt. Laughlen and Mt. Gordon is bordered by Heavitree quartzite on all sides, but it was not crossed by the party. Owing to the low and undulating dips, it is assumed that the area consists of Pertaknurra quartzite and underlying Arunta Complex and the same argument applies to the area between Paddy's Hole Plain and Love's Creek Station Valley, eastward from the Bitter Springs Gorge. Only Heavitree quartzite was definitely determined in the latter area, bordering it on three sides.

While the Pertaknurra Series is complete south of the northern side of the Love's Creek Valley, to the north of it the series is represented by somewhat irregular, faulted masses, included in the Arunta Complex. The basal bed, the Heavitree quartzite, owing to its great thickness and resistance,

still retains its identity, and the map shows the chief trend lines of this bed; but the overlying limestones of the series are much more difficult to identify with certainty, owing to their more ready assimilation in the gneisses. It was suggested in the paper on the Western Ranges that the Heavitree quartzite might be separated from the remainder of the Pertaknurra Series by a time interval, which would explain the absence of limestones associated with what were tentatively regarded as faulted down remnants of the quartzite in the Arunta Complex to the west. Chewings discusses these quartzites in the complex, both east and west of the telegraph line; and inclines to the belief that they are Heavitree quartzite, rather than an older quartzite. This point is now definitely proved. The Pertaknurra beds do not only form a marginal series to a shield of Arunta Complex, but are definitely included and partly digested in the crystalline rocks of the complex. The ranges of Heavitree quartzite, shown by dots on the attached map, were so designated because they were definitely followed and mapped from the Heavitree Range itself, at Undoolya Gap, and not on any lithological grounds, though these are strong. The absence of the Pertaknurra limestones associated with the quartzite was at first thought to be complete, partly owing to the flat dips of the quartzite in much of the disturbed areas inside the ranges; but on the return journey Pertaknurra limestone was definitely located in the Arunta Complex five miles north of the Garden Station on the Hale, and later overlying the quartzite at Winnecke Mines, where the limestones extend from the Mt. Laughlen Range almost to the Hale River. These beds were of undoubted Pertaknurra age. Other highly calcareous beds were found in the complex, but these could not be definitely identified. One such was just south of the Police Station at Arltunga, and another at the camp between the Florence and Lizzie Creeks. It was impossible to compare these highly altered Pertaknurra beds with the type section (Ellery Creek); in fact, no definite horizons were established in them; but it can be safely assumed that the Pertaknurra beds only are concerned in this inclusion in the Arunta Complex; for along the southern margin of the ranges the Pertaknurra is everywhere much more disturbed than any of the overlying series, from which it is separated by a conglomerate containing boulders, often full of algal remains, of Pertaknurra beds, and of Arunta Complex. This conglomerate, so conspicuous as a quartzite range, the Mt. Blatherskite Range, south of the Heavitree Gap, was shown to vary very much to the west, often disappearing. It was never conspicuous to the east; and no attempt was made on this journey to separate the Pertaknurra from the Pertatataka Series, as it was not considered worth the time involved. In fact, little attention was paid to the individual beds in the two series, except in the case of the richly algal beds in the Pertaknurra; and the two series were mapped together.

The Pertatataka and younger series in the MacDonnells lie entirely along the southern margin of the ranges, and have not shared in the same disturbances that have so disrupted the Pertaknurra. The Pertaoorrta, in the area of this map, as everywhere, is ushered in by a very persistent horizon, its basal bed, the No. 3 Quartzite. This dark red range can be recognised anywhere at a glance, and it made the mapping of the Pertaknurra and Pertatataka, lying between it and the Heavitree Range to the north, an easy matter. This red quartzite range continues eastward for 100 miles from Glen Helen Station, dies down at the racecourse, west of the telegraph line, but makes again four miles east of Undoolya Gap. There are a few breaks in it between this point and Williams Well; but beyond Williams Well it runs continuously to Acacia Well and Love's Creek Station, and far on to the

east, possibly as far as the Hale. Between the line of this range and the Todd River lie the Pertaoorrta (Cambrian) beds, with remnants of Larapintine (Ordovician), and a repetition by synclinal folding of the Pertaoorrta and Pertaknurra Series forming the border of the Todd Plain. This area between Love's Creek and the Todd is called the Fergusson Ranges.

Now, to turn to the area north of the Plenty River, beyond the MacDonnell Ranges. The Arunta Complex is continuous across the Plenty Plain. Low outcrops are frequent along the plain itself, and low ridges are found on the north side of the river; but no exposures were seen on the south side along either route traversed, between the Hart's Ranges and the river, other than the flat-topped "Arltungan" hills of Tertiary and Quaternary age, and the Aruntan rocks in the Entia Creek at the scoop holes.

The basal beds of the Pertaknurra, corresponding to the Heavitree quartzite, are met with along the south side of the Mopunga Range, extending westward towards the Fraser. The Marshall rounds the eastern end of this range, where the range is cut off by a fault. The river probably flows in granitic country at this point, as the track to the east of it lies in granitic Arunta Complex. On the eastern side of this wide gap lies an arc of hills forming a range, terminated by Mt. Sainthill. This range represents the base of the Pertaknurra. It turns and runs eastward to the Oorobbra Rock-holes, where the basal beds are a granite arkose, and then continues on eastward as the Jervois Range. To the north of this roughly east-west line of basal beds, lie the continuous series of Pertaknurra, Pertatataka, Pertaoorrta and Larapintine formations, with a general east and west strike, and northerly dip; in fact, the conditions to the south of the MacDonnell Ranges, where the younger formations strike east and west, and dip south off the Arunta Complex, are exactly reproduced, but to the north the dips are in general less, and erosion has not produced the imposing ranges of the south.

The northern ridge of the Mopunga Ranges is the No. 3 Quartzite, the base of the Pertaoorrta (Cambrian); and the Marshall to the north of the ranges flows through gently undulating Pertaoorrta limestones. The Larapintine beds overlying the Pertaoorrta form the nearly horizontal tablelands, which have a southerly front running more or less east and west from the north side of the Bundey River to Picton Springs and beyond. The northerly extension of these Ordovician tablelands is not yet known. Pertaoorrta (Cambrian) beds probably form frequent inliers to the north of the map.

The section across the map from the Larapintine tableland to the Todd River illustrates the general structure of the country. The main ranges and the Plenty Plain are seen to be the Aruntan core of a great anticlinal formation, bordered by the Mopunga Ranges to the north and the Fergusson Ranges to the south, each range composed of the same series of younger formations. The faulted-down remnants of the Pertaknurra series are shown between Love's Creek Valley and the Hale. No Pertaknurra limestone was seen where the section line crosses the Mt. Laughlen—Mt. Gordon ridge, as this point was not visited; but the limestone was definitely determined at Winnecke, further west along the ridge. The section is generalised as regards this one point only. The limestones are absent above the quartzite along the south side of Paddy's Hole Plain. Intrusive rocks have assimilated the limestones in places. No limestones were observed north of the White Range and east of Mt. Gordon.

The folding of the Fergusson Ranges consists of two synclines and an anticline, the synclines being occupied by Larapintine quartzites. The

broader synclinal structure brings the Pertaknurra and Pertatataka series to the surface along the southern margin of the ranges facing the Todd River.

The section shows the main localities for intrusive rocks in the Arunta Complex; but beyond this no attempt has been made to differentiate the Aruntan Series.

Some details are given below of the other series. The type section at Ellery Creek of the MacDonnell Ranges formations was described in considerable detail in the author's paper on the Western MacDonnells, the whole section having been paced; but here to the east the main object was to identify the different series and map them, less attention being paid to detail.

The distribution of the formations has been outlined above. Below follow some lithological notes.

(b) The Arunta Complex, Mica Mines, and "Rubies."

The Arunta Complex, in its great extent, includes almost all known varieties of the crystalline schists in the broader sense, as well as deep-seated intrusive rocks, and dykes, and veins. Much detail work in circumscribed localities would be necessary in order to attempt any sorting out and arranging of the broader components of the complex. The relative age of the important intrusives cannot be ascertained on a traverse such as this. All that can be offered at present is a few generalities, as the proportion of the complex covered by the traverses was very small.

In a general way, in the neighbourhood of the telegraph line, and from Alice Springs to Undoolya Gap, the rocks are granites, gneissic granite, and coarsely banded gneiss, with a general absence of the schistose rocks, and a suggestion of an igneous origin for most of the occurrences; while the southern slopes of the Hart's Ranges are characterised by finer-grained schistose rocks, of a much more sedimentary facies, and a scarcity of the coarser-grained, granitic type of rock. The northern front of the Hart's Ranges, however, shows again coarsely crystalline rocks, with much granite and minor intrusives. The outcrops in the Plenty Plain, and south of the Mopunga Range, are of the banded gneiss variety, with pegmatite veins, and granite intrusions are again the dominant factor as the margin of the younger rocks beyond the Plenty is approached.

At the Alice Springs Telegraph Station (now no longer a telegraph station, but a home for half-caste girls, the post office having been moved into the town near the railway station) the rock is a grey two-mica granite, which rock extends several miles to the north, giving way to more schistose rocks at Bond Springs. From Alice Springs to Undoolya Gap the track lies in gneissic granite, in yellow, rounded knolls, with typical spheroidal weathering, and a similar general facies to the Telegraph Station outcrops. No schistose rocks were seen; but there are some quartz veins, with large beryls in one case, half a mile from the town, and frequent basic dykes with a south-east to south trend. Gneissic banding was occasionally seen.

The rock underlying the quartzite at Bald Hill was banded gneiss. The track from Bald Hill to Bond Springs is over a mulga plain of red, sandy loam, with patches of quartz chips and low gneiss outcrops here and there. Some spinifex-covered knolls were seen, with travertine, suggesting limestones, for which spinifex shows a marked preference.

Paddy's Hole Plain shows low, isolated outcrops, with frequent patches of quartz chips, indicating the presence of quartz veins below the soil. Dark schist outcrops are also common. The basal Pertaknurra quartzite at the point examined, the large gap south of Paddy's Hole, plunges down into

a coarse silicious gneiss, with lenses of quartz, a decomposed quartz—felspar—sericite rock with talcose partings.

South of the Arltunga battery the gneiss trends north-south, and includes a calcareous belt. Asbestos was once obtained there, but never exploited. North of the battery the trend of the banded gneiss becomes east-west, with east-west quartz veins occurring between the battery and Mt. Gordon. Mt. Gordon is composed of highly altered basal beds of the Pertaknurra, with a northerly dip. The rock is in part quartzite; but mainly a quartz schist, with interbedded quartz biotite gneiss.

From Arltunga battery to White Range mines, and thence north on to the Hale Plain, the rock is schistose gneiss, with no obvious igneous intrusions, but with frequent quartz reefs trending east-south-east, many of which have been worked for gold.

The No. 1 well at White Range mines is in fine-grained, finely-banded grey micaceous gneiss. The Pertaknurra quartzite at the mines plunges into greenish, finely-banded gneiss, with sericitic and talcose partings.

On the south side of the Hale, in the neighbourhood of Claraville and Ambalindum Stations, there is no deep soil. Low gneiss outcrops are frequent. The dry well two miles south of Claraville, where a battery site was proposed, is in augen gneiss, rich in biotite.

The Claraville well is sunk in river gravel till it meets a finely-banded biotite gneiss, with biotite, quartz, felspar, and epidote.

Between Claraville and the Tug gneiss was passed over, with quartz veins tending east-south-east.

The track between the Tug camp and the camp between the Florence and Lizzie, lay in a valley, with reddish gneiss to the south, suggesting granite rock, and darker gneisses to the north, of probable sedimentary origin. One specimen from the south side was an aplite gneiss. The Florence where crossed was full of garnet sand, but so far no garnet rock had been seen in situ. East of the Florence, garnet gneiss was entered. At the camp site, where the motor road was met on the north side of the valley, there was black, fine-grained biotite gneiss full of garnet, forming an east-west ridge. The beds trended 20° S. of E., and dipped 10° N., and included a band of calcareous rock, two feet thick, a marble with much brown mica. The reddish rock to the south of the track here fades away, giving a view down the Lizzie and over the plains to the east and south, where only scattered hills are dotted about.

North of the motor track, the Lizzie flows entirely in garnet gneiss of low northerly dip. The gneiss is injected with white pegmatite lenses and lenses of more basic material, forming augen several feet long by a foot or more wide, the gneiss and the lenses alike being crowded with garnet. At one point the gneiss was built up of broad bands or lenses of the following description:—A white lens of coarse-grained quartz, albite and biotite, studded with garnet from the smallest grains up to crystals an inch and a half in diameter, sericite schist full of garnet, coarse black biotite gneiss, and hornblende gneiss consisting of coarse hornblende, quartz and garnet. At this point, two miles above the motor road, the dip was 12° N. The beds appeared to be of sedimentary origin. Garnetiferous rock is continuous right across to the northern front of the ranges, beyond which garnet was not seen.

At the divide at the head of the Lizzie, the trend is south-east, and the dip has increased to 45° N.E.

The sands of the Florence and Lizzie, and of the Hale below the confluence of these streams, are largely composed of garnet, which was once thought to be ruby, causing a rush some fifty years ago. The "rubies" were shown to be garnets by the late Prof. Rennie in 1888, when he made an

analysis (18). This showed the garnet analysed to be an almandite, with silica 38·48, alumina 27·09, ferrous oxide 26·28, lime 1·99, magnesia 4·20, and manganese 0·35. All the garnets are reddish, but the colour varies; and many are common garnet, not possibly mistakable for ruby. On the other hand, some fragments from the gravels are of exactly the ruby shade; and, in the absence of crystal form, more than a mere glance is required to distinguish them from rubies. Apparently no dichroscopes were available in those days.

Excavations for "rubies" on the banks of the Florence were seen, with heaps of "gems" still lying there.

A detailed examination of sands from the Florence is in hand. Garnet forms 52%, black tourmaline, 25%; and epidote, diopside, hornblende, quartz, felspar, and mica are well represented.

After the Lizzie divide is crossed, quartz and pegmatite veins become much commoner, with coarse muscovite conspicuous for the first time; and granite intrusions are seen in the low ground. At Sprigg's Camp the gneiss has a low northerly dip. The pegmatite dykes have a general east-west trend, but there are many exceptions. They are from a foot or two to ten or twelve feet wide, and all show coarse muscovite.

A fairly fresh granite in the main creek-bed, east of Mt. Palmer, is grey and coarse-grained, with white felspar, quartz, muscovite, and biotite; the thin section showing quartz, microcline, oligoclase, biotite, muscovite, and apatite, in that order of abundance, with some micrographic quartz-felspar intergrowth. This granite was not gneissic, and was considered the parent rock of the pegmatites.

The gneiss in the neighbourhood of Mt. Palmer is highly garnetiferous, and all creeks contain much garnet, in larger crystals than south of the divide, but of much poorer quality. The garnets from this region are now known as "Australian Ruby," and are much used in the cheaper jewellery. They are a pretty stone, commonness being their only fault.

The mica mines and "shows" are on Mt. Palmer and in its immediate vicinity, and are also strung out along the front of the ranges in the foothills for a distance of twenty miles. From the track along the front of the ranges, from west of the "Marked Tree" almost to Mt. Mary, the white pegmatite veins can be seen streaking across the hills; and turn-offs from the track into the scattered workings are met at frequent intervals. Old camp sites are scattered all along the track, with glistening heaps of mica refuse, where the material has been sorted over, and the best selected and made into parcels. There are a few "shows" on the Maude, on the southern watershed of the Hart's Ranges; but by far the majority are on the northern watershed, and most in the foothills bordering the plain. The country is mainly garnet gneiss, with granite intrusions exposed in the low ground, particularly along the track in front of the ranges, and pegmatite dykes in the higher hills, with also many less conspicuous basic dykes. The most extensive mica workings are Stone's Mica Mine, on the track four miles west of the Marked Tree, and the mines on Mt. Palmer, the "Spotted Dog" and the "Disputed" on the east side, and the Oolgarinna on the west side. Work on the "Oolgarinna" and "Disputed" had been restarted in 1931.

The rock at the camp on the east side of Mt. Palmer was a light-coloured biotite garnet gneiss, trending E. 40° S., very cellular where garnets had weathered and fallen out, leaving reddish cavities. Towards the mountain-side the rock was an amphibolite gneiss streaked with quartz and felspar bands, a very common variety of gneiss in the Hart's Ranges. The mountain itself is largely composed of a dark, more homogeneous hornfels-like rock,

which is particularly preponderant on the eastern slopes, possibly an altered epidiorite. The crest of the ridge of Mt. Palmer is of a light-coloured garnetiferous gneiss, suggesting an altered sandstone, and possibly a remnant of the basal beds of the Pertaknurra. The trend of the ridge is N.N.W., and the dip of the formations N.E. at 45°, and less. Most of the pegmatite veins trend south-east.

The Spotted Dog pegmatite vein is vertical, 12 feet wide, and trending 5° E. of S. Narrow basic dykes border the pegmatite on each side. The felspars are two feet and more in diameter, and produce beautiful cleavage pieces on mining. Black tourmalines six inches in diameter and several feet long are common, while clear sagenitic quartz, shot through with black tourmaline rods, is an interesting feature. Beryl is rare and inconspicuous. Muscovite occurs in large segregations, in which books, whose "leaves" measure a foot or more each way, are not uncommon. The larger specimens, however, are almost invariably flawed; 6 inches by 4 inches is looked on as a good average size for the marketable quality. Even the best material is slightly iron-stained. The mica masses are irregularly distributed throughout the pegmatite, and the miners have no indications to go on in the search for it. A lot of work in the hard rock, either solid quartz, or quartz and felspar, with hammer, drill, and explosive, must be done in order to break out a mass of mica, all of which sometimes proves to be below commercial standards.

Thin sections parallel to cleavage plains showed the felspar at the Spotted Dog to be a microcline perthite, with albite intergrown parallel to the 100 crystal face.

The Disputed vein is somewhat irregular. It trends N.W., and dips S.W. at 45°. The Oolgarinna, on the western side of Mt. Palmer, is vertical, 10 feet wide, and trends S.E. into the mountain-side. All these veins are on the steep mountain slopes, 700 feet above the valleys below, where the miners' camps are situated. The daily climb to work is quite a feat, and all the material won must be carried down by hand. The best mica seems to come from Mt. Palmer; that from the more accessible shows along the front of the ranges being of lower quality.

The felspar at Stone's Mica Mine showed obvious multiple twinning in the large hand specimens. Thin sections proved it to be oligoclase.

The front of the ranges, from the Marked Tree to the camp five miles east of Luce's Spring, is composed of banded garnetiferous gneiss. At Luce's Spring the gneiss trends E.S.E., with a dip of the schistosity of 50° N., and is a biotite muscovite gneiss, full of garnets. From the camp mentioned to the Entia Creek, the foothills are granitic, a somewhat gneissic granite with an easterly trend and northerly dip of the schistosity. A specimen of granite from the camp five miles east of Luce's Spring showed inconspicuous gneissic structure in the hand specimen, by parallel arrangement of the mica. A thin section revealed abundant quartz, much shattered, plentiful fresh microcline, some orthoclase, a small amount of more weather oligoclase, muscovite, biotite, and apatite. The rock is homogeneous, with parallel micas, but not otherwise gneissic in structure. Further east from this camp, biotite becomes more conspicuous in the granites.

To the west of the Marked Tree, in the neighbourhood of Mt. Palmer, the trend of the rocks is more north-south, in conformity with the ridge of Mt. Palmer; but at Mt. Mabelle it becomes east and west again, with dip slopes facing the plains. East of Stone's Mica Mine the country rock was grey biotite granite gneiss. At the gorge near Mt. Riddock, dark amphibolite gneiss was noted in the lower ground, while the peaks were formed of reddish gneiss, quartzose and felspathic, as at Mt. Palmer. Garnet was plentiful near

Mt. Riddock, but mica scarce in the gneiss. There are some mica mines at this end of the range, but no granites were seen. Epidote rock was first seen at Schaber's. Between the camp west of Schaber's and the Garden Station, buff-coloured gneiss and granitic gneiss were common, with a few quartz reefs; while there is a notable absence of garnet in this portion of the Hart's Ranges. Patches of epidotised limestone were found in this section, as described below.

Across the Hale Plain from the Garden Station, in the neighbourhood of Winnecke Mines, there is a large area of altered Pertaknurra beds, in which occur quartz reefs carrying gold; and at the Winnecke battery, basic dykes of almost solid amphibolite. The dyke rocks have been included under the heading Arunta Complex, as so many of them occur in the Complex itself; but those intruding the Pertaknurra are obviously post-Aruntan in age, as are some of the granite intrusions; but, as pointed out above, any attempt at separation at this stage would be so incomplete as to be not worth while.

Between the Winnecke Mines and Bald Hill, along the track following the foot of the Mt. Laughlen-Bald Hill range of Heavitree quartzite, lies a wide area of pink biotite granite gneiss, in which the quartzite appears to be embedded. The contact was not visited. The limestone beds seem here to have been completely assimilated by the granite intrusion. The limestone appears again in a small area at the gap where the track crosses this range further west.

On the north side of the Plenty, gneiss outcrops are frequent. From the Plenty Wells a low ridge runs north-east. The rocks have a S.E. trend, and N. dip. Pegmatite veins are fairly common, and there are several mica "shows" along the ridge. The pegmatites trend S.E. with the country rock. Garnets were associated with the mica in one excavation, the only case of this noted.

At the Mopunga Creek, which rises in the Mopunga Range, and takes a course parallel with the Marshall, at the more easterly crossing, a big limestone formation was noted on the north side of the creek. It was vertical, with a thickness of 300 feet, and strike E. by N., forming low cliffs along the left bank of the stream. The rock was a buff-coloured marble, dense and featureless, with no traces of algal or other remains. Owing to the absence of any other exposures, its relations with other formations could not be established. It is probably an outlier of the Pertaknurra limestones, though possibly an Aruntan marble.

Granitic rock outcrops along the southern margin of the Mopunga Range, and also forms the lowland between the eastern end of the Mopunga Range and the Mt. Sainthill arc. The basal beds of the Pertaknurra in the area are a granite arkose, but were probably not derived from the granite exposed there now, which seems to engulf the arkose, particularly in the case of the Mt. Sainthill arc. Granite specimens from the north end of the arc, and from granite knolls between this point and the Marshall, along the front of the limestone outcrops north of that line, were examined in detail. This granite shows no gneissic structure. It is characterised by large, reddish felspars, and is much coarser-grained than any other rock seen in the area. Thin sections showed the granite to consist of large microcline and microcline-perthite crystals, quartz, small quantities of acid plagioclase, and very little ferro-magnesian mineral, only biotite and iron ores being recognised. The quartz was much crushed and strained. A boulder of this pegmatitic granite was found to be reticulated with narrow veins of purple fluorite, an isolated example. The boulder was of brecciated granite. No similar rock was found in situ.

(c) The Pertaknurra and Pertatataka Series.

These two series have not been separated on the map, as explained above.

The No. 2 Quartzite separating them is not conspicuous to the east of the telegraph line. It is probably represented by the flagstone forming a ridge in the Love's Creek valley, the first ridge north of the station house. The basal bed of the Pertaknurra, the Heavitree Quartzite, forms the main range eastward from the Heavitree Gap, and its branches and virgations have been described. At Undoolya Gap the ridge is faulted, the eastern side of the gap being displaced southward. The dip here is 55° S. North of Love's Creek Station the dip is reversed to 70° N. The rock is there pink, a coarse grit in part, with grey flinty bands. South of Paddy's Hole Plain the range is almost flat on top, with a gentle northerly dip; but it suddenly plunges down on the northern side into the Arunta Complex. Here the rock is pink, dense and gritty, felspathic in part, and showing well-preserved ripple marks.

In the White Range, a continuation of the Paddy's Hole Plain Ridge, the quartzite is white to blue-grey, and flinty. The dip at the east end of the range, in the neighbourhood of the mines, is N. to E.N.E. as the range curves round, and of low angle, being 15° at the mines, where the slopes are dip slopes. Here again the dip steepens up as the quartzite plunges down into the complex. The contact of quartzite and gneiss is seen in Plate III., Fig. 3.

The nature of the basal beds is rather different across the Plenty. There it is a coarse arkose, conspicuously developed at the Oorobbra Rockholes, where it has at first sight all the appearance of an aplitic granite, stratification being absent, and joints few. The weathering is smooth and spheroidal. At the rockholes the dip is gentle, the rockholes creek occupying a syncline. The thickness of the arkose is about 150 feet. It is coarse-grained, the chief minerals being quartz, felspar, and muscovite, with very few dark minerals. Followed westerly from the rockholes, the arkose develops a vertical dip, and then swings round southerly to form the Mt. Sainthill arc. This arc is mainly composed of granitic rock, with a capping of quartzite and arkose, dipping easterly. West of the Mt. Sainthill arc the Marshall flows in granitic rock, but across the river the arkose again appears as the most southerly ridge of the Mopunga Range, where the dip is 45° N. The arkose is there in part very coarse, consisting of large pink felspars, large quartz pebbles, without conspicuous rounding, and green mica. In part it is finer-grained than at Oorobbra Rockholes, where the grain-size is remarkably uniform. Plate V., Fig. 2, shows the arkose at the upper rockhole at Oorobbra.

Eastward of the rockholes is Grant's Bluff, the western end of the Jervois Range. Here the arkose is conformably overlain by flaggy micaceous quartzite a hundred feet thick, dipping 15° S., and trending east. It is full of ripple marks, sun cracks, and worm tracks and castings. The beds are flaggy, in part a dense quartzite, in part coarse felspathic grit, and micaceous sandstone. The rock contains many oval cavities, and on the faces of slabs concentric rings are common, possibly partial concretions. This type of markings is common in quartzites of the Adelaide Series, and was remarked on in connection with the Heavitree quartzite in the Western Ranges. The beds at Grant's Bluff bear a resemblance to the Ordovician quartzites of the tablelands to the north, but owing to the absence of fossils they are placed in the basal series of the Pertaknurra. To the west of the rockholes, purple and grey flags definitely come between the arkose and the Pertaknurra limestones, as shown in the section in the Text Fig. 2; and the Grant's Bluff flags may safely be correlated with them.

Text Fig. 3 gives a north-south section at Grant's Bluff. Folding and faulting repeat the quartzite cliff three times, the highest cliff being

Grant's Bluff. Further to the west, at the rockholes, the flagstone has been eroded away, and the creek runs over the arkose, in which the rockholes lie. The relatively flat area to the north of Grant's Bluff was not visited. The parallel east-west ridges called by Brown the Oorobbra Reefs, are plainly seen from the Bluff. Brown was uncertain whether to call these quartz reefs or vertical quartzite outcrops. The country is obviously Arunta Complex.

Little attention was paid to the members of the Pertaknurra and Pertatataka series above the basal beds, with the exception of the so-called algal limestones. As in the Western Ranges, the main algal formations are near the base of the Pertaknurra. The first discovery of these algal forms was by Chewings, in the nearest gully on the west side of Acacia Well, and only a few hundred yards. from the well. These forms were determined as *Cryptozoön* by Howchin (19), and their horizon has been commonly referred to as the Cryptozoön limestones, as the forms are exceptionally plentiful in it; but it was shown in the description of the Western Ranges that they occur throughout the Pertaknurra, Pertatataka, and Pertaoorrta (Cambrian). Chewing's horizon extends as foothills all along the Heavitree Ridge, and close to the track, from Undoolya Gap to beyond Love's Creek Station, some forty miles. These beds are everywhere much contorted. The Pertaknurra has suffered much more disturbance than any of the higher series, as these southern sections show; and for this reason all limestones caught up with the Heavitree Quartzite in the Arunta Complex are considered to be of Pertaknurra age.

Three miles east of Undoolya Gap the beds are much disturbed. Zones of siliceous bands were noted, and coarse and wavy laminations, both indications of algal growths. Chewings' *Cryptozoön* were rare there, but at the creek three miles west of Williams Well they were plentiful. At the latter point a yellow limestone with a southerly dip of 30°, full of *Cryptozoön* and laminated masses, was overlain by red shale, followed by a massive limestone 50 feet thick, packed with siliceous ellipsoidal forms.

At Acacia Well the dip is only 17° S.E. The *Cryptozoön* bed is there 400 feet thick, containing separate *Cryptozoön* and festoon-like masses. Red beds underlie the limestone.

North of Love's Creek Station, up against the quartzite range, there is a conspicuous range of the main algal beds, 300 feet high, crowded with algal growths. The only attempt at a section across the two series was made here, further details of which are given under the description of the Ross River section. The beds reappear to the south, across the synclinal axis, to form the southern ridges of the Fergusson Ranges, as shown on the section. There they are also richly algal.

The Pertaknurra limestone was not examined in detail in the Bitter Springs Gorge, where it is very much distorted. Purple shale was seen intercalated in the limestone at Bitter Springs.

Beyond the Plenty, where the Ross River sequence is repeated, there was little time for detailed work. The basal beds were examined near the top of the Mt. Sainthill arc, three miles west of Grant's Bluff, and one and a half miles west of the beginning of the rockholes. Text Fig. 2 shows a north-south section at this point. The arkose, which is there vertical, grades into flaggy, siliceous slates, and then into quartzite, which latter forms a prominent ridge a couple of hundred feet high. The arkose is 240 feet thick, and thinning rapidly westward. The slates are about 600 feet thick, and the quartzite 250 feet. The dip gradually lessens to the north, where calcareous slate, overlying the quartzite, merges into solid algal limestone, with undulating but gentle dip. The limestone is yellow and dolomitic, with masses of

magnesite on the surface. The sections, Text Figs. 2 and 3, show the same type of beds in each section overlying the complex, which is granitic, with quartz veins, in both cases. The limestone has been eroded from the Jervois Range at Grant's Bluff, but it is probable that the mineralized limestone at the east end of the range, where the silver-lead-copper finds were recently reported, is Pertaknurra limestone.

Between the Huckitta-Picton Springs area and the latitude of Mt. Benstead-Bitter Springs, very little indications were observed of limestones associated with the remnants of Heavitree Quartzite faulted into the intervening wide area of Arunta Complex. The only definitely established patches of Pertaknurra limestone were four miles north of the Garden Station, in the Hart's Ranges, and at the Winnecke Mines. At the first locality, half a mile up the gully from the plain, on the track from Garden Station to Schaber's, and three miles from the Hale, a belt of limestone half a mile or more long, 20 feet wide, vertical, and trending S. by W. along the track, was observed, embedded in gneiss. This was a calcareous conglomerate, with boulders and pebbles of gneiss and quartz standing out on the weathered surface, and containing masses of siliceous ellipsoids, so characteristic of one zone of the Pertaknurra algal limestone. The rock matrix was of recrystallized calcite, containing yellow and green grains of epidote and diopside. Thin sections showed the rock to consist in general of calcite, large quartz aggregates, diopside, garnet, and scapolite. One specimen showed no quartz, but garnet and scapolite in large excess, with subordinate calcite and monoclinic pyroxene. No quartzite was seen in the vicinity, but time did not permit of much investigation being made at that stage of the return journey.

Another mile up the creek, and just below the divide, a belt of quartz-epidote rock, 10 feet wide and 150 feet long, with an east-west trend, and embedded in gneiss, was passed. This may have been derived from the Pertaknurra series. The thin section showed the rock to be almost entirely composed of epidote and quartz, with epidote in excess.

Between these two points, and in their neighbourhood, there are no doubt other occurrences of calc-silicate rocks and marbles, but only the track along the creek was followed, and that hastily.

Between the Hale River near Winnecke's Depot and the Winnecke Mines, another area of Pertaknurra beds is shown on the map. This is consistent with the position of the Petaknurra basal quartzite forming the Mt. Laughlen-Bald Hill Range, which dips north. The area was only examined on the north and south sides. On the north side, along the Hale, highly altered limestone containing green grains was interbedded with gneiss, and one pegmatite dyke was noted, crossing the beds. No algal formations were seen in the small area inspected. The limestone bands were narrow, and trended W. by N. The calcareous area was assumed to continue across to the mines. It was not crossed, but skirted round to the west, where granitic gneiss bounds it.

At Winnecke Mines, on the south side of the area, slate was seen to overlie the Heavitree Quartzite, followed by an observed thickness of 500 feet of altered limestone of the same character as that seen north of the Garden Station and along the Hale. The dip was 45°N., strike E.S.E. The rock consisted of calcite dotted through with greenish grains of epidote and diopside, with some quartz. It is undoubtedly altered Pertaknurra limestone. The thin section revealed a fine-grained aggregate of calcite, quartz, epidote, and subordinate green pyroxene (diopside). The epidote is sufficient to impart a green colour to the rock, and scattered larger grains may be observed in the hand specimen.

The patch of limestone at the Gap, six miles west of Winnecke's Mines, was not examined, but merely noted from the camel's back. There are probably many more such patches of altered limestone and other younger beds included in the crystalline rocks of the headwaters of the Hale.

(d) The Pertaoorrta Series.

The Pertaoorrta Series, now definitely known to be of Cambrian age, has its base in the No. 3 Quartzite, that dark red range everywhere conspicuous along the southern flanks of the MacDonnell Ranges, and always a mile or so south of the main Heavitree Range. The choosing of this formation as the base of the Cambrian is arbitrary, and was discussed in the author's paper on the Western Ranges. The upper limits of the Cambrian are more definite in the basal quartzites of the Ordovician (Larapintine).

The No. 3 Quartzite is the only member of the Pertaoorrta Series exposed at Alice Springs Racecourse on the west side of the telegraph line. It disappears beneath the Emily Plain to the east, to reappear again just east of Undoolya Gap, from where it forms an almost continuous southern wall and boundary to the track round past Williams and Acacia Wells to Love's Creek Station and far beyond to the east. It is remarkably uniform in appearance, rising to three and four hundred feet above the general level, and consisting of a fine-grained purple-red quartzite, flaggy in places, and with many small oval-shaped cavities, suggesting moulds of bivalves, or weathered-out clay balls. There are some fault breaks in the range between Undoolya Gap and Williams Well, but from Williams Well it is quite continuous as far as seen, some ten miles beyond Love's Creek Station. The formations overlying this quartzite are mainly massive limestones in this area, occurring on the south side of the red range, which everywhere dips south. No Pertaoorrta is found north of the range in the MacDonnells. It recurs only far beyond the Plenty, in the Mopunga Range, the northern limb of the great anticline.

Further details of the southern Pertaoorrta formations are given below, under the description of the Ross River section. In the northern area, the No. 3 Quartzite was recognised as one of the ridges in the Mopunga Ranges, but the overlying beds were not examined in detail. The quartzite dipped north, and was followed towards Huckitta Station mainly by limestone beds of northerly and undulating dip, as seen in the main map section. At Huckitta Station, the dip had increased, and was observed to be 50° north, in calcareous slate and sandstone, close to the overlying Larapintine sandstone tableland. The rock there was full of worm casts and trails, particularly in greenish calcareous slates.

West of Oorobbra Rockholes the formations were crossed north of the camp site shown on the map. This camp was at a point of considerable disturbance, the top of the Mt. Sainthill arc, where granite intrusions and contemporary movement had thrown the beds into confusion. The granite was bordered on the north of the camp, as for a considerable distance to the west, by Pertaknurra limestones, including some purple slates, but at one mile north, the No. 3 Quartzite, the base of the Pertaoorrta, was recognised, a thick, flaggy quartzite with the usual hollow impressions. The beds near the camp were nearly vertical, with the dip rapidly flattening to the north, and becoming almost horizontal in rising ground at three miles. The beds above the basal quartzite of the Pertaoorrta were mainly limestones. Obscure remains of Archaeocyathinae were found in the locality, and cylindrical forms suggesting *Salterella*, also possible Trilobite fragments, but the preservation was too poor to warrant further study of the specimens

taken. Good "*Cryptozoön*" were plentiful. One "head" was a fan-shaped mass five feet across and two feet six inches high, entirely built up of the Chewings type of "*Cryptozoön*," cylindrical laminated tubes, with laminae convex upwards, and all radiating from the base.

The Pertaoorrta in the northern area is bounded to the north everywhere by the overlying Larapintine tablelands, though it is probably exposed again to the north and north-east, as the Cambrian Trilobites *Agnostus* and *Microdiscus*, were discovered near Elkedra Station, in the Davenport Ranges, 100 miles north by Davidson, and identified by Etheridge, Jnr. (20). So far, no geologist has further investigated that area.

(e) The Larapintine Series.

The Ordovician (Larapintine) Series in the Eastern MacDonnells does not make anything like the grand development that it does in the west. It has been almost entirely removed from the eastern ranges, if indeed it ever attained the same great thicknesses there. The only occurrences observed were in the Fergusson Ranges along the Ross River section, where Larapintine sandstones and quartzites occupy the synclines as inliers in the Pertaoorrta. These are only the basal beds of the Larapintine, lying conformably on the Pertaoorrta limestones, and confirming the opinion formed in the west, where the junction of the two series is in more steeply dipping beds, that there was no marked angular unconformity between the series. The beds in these synclines are "worm-eaten" quartzite, with moulds suggesting *Isoarca*. They are calcareous towards the base, where the rock is a white, gritty sandstone and arenaceous flagstone, becoming denser quartzite above. Stream bedding is conspicuous, with black lines of ilmenite, worm tubes and casts, and bivalve impressions. No good fossils were found. These remnants of the basal beds of the Larapintine showed a maximum thickness of about 250 feet, the height of the cliffs and ridges they form above the general level of the Pertaoorrta limestones on which they rest.

The Ordovician (Larapintine) tablelands in the north-east corner of the map were only examined at Huckitta Station, and then there was only time to climb the scarp at the station. The scarp is there about 300 feet high, and quite flat on top. The beds dip north at 7°, and the scarp runs generally east and west. The top 50 feet is strongly silicified. The rock is quartzite, flaggy quartzite, and sandstone. A long scree, from about half way up the scarp, obscures the lower beds. The upper hundred feet or so is almost vertical, and quite difficult to scale. Poorly preserved fossils were plentiful in boulders in the scree, but the exposed beds were unfossiliferous. From the position of the highest fossiliferous boulders it appeared that the chief fossil horizon was near the top of the scree, and half way up the scarp. *Orthis* and *Isoarca* impressions were common, and what appeared to be Trilobite fragments. Mr. Tindale brought back mainly *Pleurotomaria* casts from near Mt. Ultim, which lies to the west along the same tableland edge.

(f) The Arltungan Beds.

In the Todd, Paddy's Hole, Hale, and Plenty Plains there were found low, flat-topped hills made up of beds of sands, clays, gravels, and limestones, unconsolidated, except for the "duri-crust," and flat-lying or gently dipping in conformity with an older land surface, their flat tops. They had every appearance of being remnants of an older filling of the same valley plains in which they now lie. One such was described from the western region, in the plain in the middle of the Waterhouse Range, where coarse gravel contained large silicified tree trunks. Where the Jay Creek enters the plains

from the last Larapintine quartzite range, similar gravels and some limestone were noted. In the east, where the Ross enters the Todd Plain, at the camp marked, there was a rise 100 feet high, sloping gently southwards towards the Todd. At the north end it was composed of Pertaknurra limestone, much silicified, but further along the old outwash clays and gravels formed the entire mass, which sloped almost to the plain in 600 yards. This limestone outcrop marked a former southern front of the Fergusson Ranges, and the tail of debris a section of the old alluvial fan. Similar flat-topped, sloping remnants were seen in the same locality, and one, not visited, but much longer in extent, lies as an isolated hill south of Undoolya Gap. The latter, though the evenness and slope of its top obviously indicates an old land level, may be composed of the older (Pertaoorrta) sediments. Such remnants are indicated in the Ross River, Text Fig. 1, on the Todd Plain, and also, in the main map section, on all the plains mentioned above.

On the south side of Paddy's Hole Plain these remnants were very common. Close up to the quartzite range, flat-tops are seen sloping gently down to the plain. Here a few feet of porcellanite covers felspathic grit of considerable dip, probably the Pertaknurra Series, eroded to an older plain level. Further out from the quartzite range, and near and on the track, low limestone rises up to 50 feet high, covered with spinifex, are frequent. The limestone was found to be formed almost entirely of *Planorbis* shells, and is a freshwater limestone, indicative of lacustrine conditions in the plain in former times. It was on this plain, and at the foot of such a hill, that Mr. O'Grady found the silicified Osmundaceous stems, which appeared to have weathered out of the hill, and there can be little doubt that they had done so. The Arunta Complex outcrops here and there on the plain, the soil of which is shallow, and there is no other formation between these flat remnants and the Complex.

Dr. A. B. Walkom, in a private communication, has kindly determined the stems as those of Osmundaceous plants. Up to the present, all the fossil Osmundaceous remains in Australia and New Zealand appear to have come from Mesozoic formations. Mr. F. Chapman, with his kind and ever-ready assistance, wrote that the *Planorbis,* while unlike the usual numerous keeled species living in Australian freshwater streams and lakes, resembled *P. Hardmani,* the supposed Pleistocene species of the north-west, though of much smaller dimensions. One is strongly inclined to date these remnants as Pleistocene, though the Osmundaceous stems are a difficulty. The plains inside the MacDonnell Ranges may be of great antiquity, dating back to Cretaceous times, but there is certainly no considerable thickness of Cretaceous beds. The ferns are possibly a carry-over of an older flora, just as those interesting palms, *Livistona mariae,* are found growing today in Central Australia in one spot only, a tributary of the Finke in the Jervois Ranges, called Palm Valley.

In the Hale Plain these young beds are common. They are mentioned above in the narrative, in connection with the well from which lignite was obtained. The deposits are blue clay, full of gravel and boulders, and sands, with ironstone cappings, in places porcelainized. The thickness is at least 60 feet, including the height of the rises, and depth of the well.

On the north side of the Hale, between Ambalindum and Claraville Stations, spinifex-covered rises are frequent. These beds are very calcareous, and consist of arenaceous and gritty clays with a travertine capping, and are in the neighbourhood of 50 feet thick. The travertine contained plant stems like *Chara,* and small bivalves, possibly *Corbicula,* according to Mr. Chapman. These beds have a decided Pleistocene facies. In places they are capped

by transparent or translucent pure chalcedony, which appeared in some cases to run in veins rather than as a surface sheet.

On the Plenty Plain, the flat-topped remnants are much bigger and more conspicuous, standing out as small tablelands or mesas. Some are indicated on the map near the route followed. One, lying two miles S.S.E. of Plenty Wells, was visited. This is marked on Brown's map as "Primary rock." The "flat top" was found to stand about 90 feet above the plain. The bottom 50 feet was grey sandy clay, overlain by 15 feet of red ferruginous sandstone, and capped by 25 feet of white chalcedony, the thickest of such cappings observed. The beds were horizontal, and very similar to those in the rises at the "coal well" on the Hale Plain. The red sandstone was porous, suggesting the removal of silica to the capping, where it may have replaced an original travertine capping. A little travertine was still to be seen about the top of the mesa.

Tindale reported many of these low, flat-topped mesas in the neighbourhood of MacDonald Downs Station, where the capping of chalcedony was a feature.

These remnants of younger formations in Central Australia are seen to have many features in common. They are horizontally bedded, of alluvial and freshwater sands, clays, gravels, and limestones; their maximum thickness may be put down at 100 feet; and their arrangement conforms with the present drainage system, but indicates a higher base-level of erosion. The only fossil evidence is given by the Osmundaceous stems, characteristic of, but not necessarily confined to, the Mesozoic, the *Planorbis* and *Corbicula*, suggesting Pliocene or Pleistocene, and the unidentified fossil tree limbs. The "duri-crust," of chalcedony, porcellanite, or limonite, is characteristic of the whole region, including the Artesian basin, and northern South Australia. To the south of the MacDonnells, outcrops of all formations, from the Permo-carboniferous upwards, have been thus levelled and porcelainized, and subsequent further lowering of the base level has given us the typical tableland country of "tent hills." These tent hills, or "flat tops," were formerly all grouped under one heading, the Desert Sandstone, and considered to be of Upper Cretaceous Age. Undoubtedly many such hills are of this age, the freshwater Winton Series, but the author has seen many hills to the north of Horseshoe Bend on the Finke, of Finke Series sandstones (of Permo-carboniferous or possibly Jurassic Age) that are typical "Desert Sandstone" hills. R. Lockhart Jack (21) has found up to 360 feet of sands and clays unconformably overlying the Winton Series in the north-east corner of South Australia, which he refers to as the Eyrian beds, of an age so far indeterminate, beyond the fact that they are supra-Cretaceous, and these would also come under the category of "Desert Sandstones." The flat-topped formation and "duri-crust" cappings are no indication of the age of the beds concerned.

The term "Eyrian" was first introduced by Woolnough and David in a paper on Cretaceous glaciation in Central Australia (29). It was adopted by L. K. Ward in his new edition of the Geological Map of South Australia, 1927, and discussed in the pamphlet accompanying the map, an appendix to the Annual Report of the Director of Mines and Government Geologist of South Australia, 1927. Ward says that in South Australia the Eyrian cannot be distinguished lithologically from the Lower and Upper Cretaceous rocks which have suffered the same weathering and superficial silicification.

Sir Edgeworth David's New Geological Map of the Commonwealth shows large areas of Eyrian formations in northern South Australia and New South Wales, described in the legend as Eocene (Mesas of the

Australian Great Artesian Basin). Ward remarks in the pamphlet that the Eyrian on his map of South Australia must be regarded as subject to adjustment in the future.

The MacDonnell Range formations of this character cannot be clearly correlated with any of those mentioned, and as they make a distinct unit, at least geographically, and also as some fossil evidence is to hand, it is proposed to class them by themselves as the Arltungan formations.

It is suggested that the MacDonnell Ranges have been a land area little disturbed since the close of Palaeozoic times, subject only to erosion, and that the Arltungan beds are the remains of all the temporary terrestrial deposits formed in the river valleys in the ranges during the subsequent periods. A slight uplift in Pleistocene times initiated the latest attack on the alluvium, the erosion of the Pleistocene plains, and the remnants of those plains are the Arltunga beds of today. They are made up of Tertiary and Quaternary deposits, mainly Pleistocene, with some lignite of possibly Tertiary Age. The Osmundaceous stems may be derived fossils from eroded Mesozoic freshwater beds, or a Tertiary remnant of a Mesozoic flora.

(g) The Ross River Section.

When it was seen that the high range on the north side of the Love's Creek Valley was the Heavitree Quartzite, and that the Fergusson Ranges to the south of the station represented the same sequence as the type section of the MacDonnell Range formations at Ellery Creek, it was decided to run a section down the Ross River, which conveniently crosses the beds at right angles. The section was not studied in more detail than was necessary to establish the correspondence of the two sections. The four miles from the Heavitree Quartzite to the first appearance of the Larapintine beds was paced, but from the latter point to the Todd Plain it was a camel traverse, twice travelled.

Commencing at the north end of the section, Text Fig. 1, the Heavitree Quartzite forms the high, red range, rising 750 feet above the valley floor. The range was ascended, but not crossed. The dip on the south side was 70° N., a reversed dip, and the thickness of the quartzite was roughly estimated at 1,000 feet, but may have been more, as the width of the range considerably exceeded that amount. The crystalline rocks on the north side were not inspected at close quarters.

Several rough ridges of limestone form parallel foothills along the southern side of the range, as everywhere along the Heavitree Range, and these ridges showed the same characteristics as at Ellery Creek. Unfossiliferous dolomite overlies the limestone, with some intercalated slates, still dipping north, and then follows a zone of brecciated limestone of indeterminate dip, indicating a fault. The dips are variable in the vicinity, with some horizontal beds. The zone is a crush zone, and the beds are more thrown about than indicated in the section, which is there diagrammatically simplified. Beyond the brecciated zone and 800 yards from the quartzite, a prominent ridge of massive limestone runs east and west, rising to some 300 feet above the valley floor. This limestone is almost entirely composed of algal forms, mainly of the Chewings' *Cryptozoön*, and forms the chief of the foothill ridges. The dip varies from flat to 30° S. in the ridge. The main limestone ridge is followed by four more smaller limestone ridges, with interbedded red shales, the third being narrow, but very massive, and full of siliceous nodules and bands, a conspicuous horizon in the Pertaknurra, in the western ranges. The dip here, just a mile out from the quartzite, is about 20°, increasing to 30° S. on the south side of the Love's Creek

Valley. Calcareous and slaty beds follow these limestone ridges in flatter ground, and at one and a half miles from the main range, a ridge of flagstone occurs, 100 feet thick. This is the most arenaceous bed in the valley, and was taken to represent the No. 2 Quartzite, the base of the Pertatataka. The beds of the Pertatataka Series, overlying this flagstone, are mainly obscured under the soil of the valley floor. They contain a few small limestone ridges.

The next conspicuous formation is a long ridge of dark limestone, forming the southern side of Love's Creek Valley, behind which rises the dark red No. 3 Quartzite range, the base of the Pertaoorrta. The Love's Creek Station lies at the foot of the limestone, at the entrance to the Ross River gorge. From this point to the Todd Plain, the Ross cuts a continuous section across the beds, the Pertaoorrta being particularly well exposed.

The first formation at the entrance to the Ross Gorge, at Love's Creek Station, is the dark compact limestone, exposed for a thickness of 330 feet, dipping south at 30°, and showing no signs of organic life. It forms a ridge about 150 feet high, and the station house is immediately at the foot of it. The limestone is followed by a dark red micaceous shale, occupying a small gully behind the limestone. The shale is 500 feet thick, and becomes more arenaceous towards the top, merging into the No. 3 Quartzite, the red range, which rises to about 350 feet, and is taken as the base of the Pertaoorrta. This quartzite is coarsely flaggy, and with jointing, splits into great square purplish blocks. Moulds suggesting bivalves are common, as everywhere in this formation. The beds bear a strong resemblance to Howchin's Purple Slate Series, which form the transition beds in the Adelaide Series between the Upper Pre-Cambrian and the Cambrian, in South Australia. The quartzite is here 600 feet thick. A small cross gully separates the basal quartzite (No. 3 Quartzite) from a very thick and massive limestone. Archaeocyathinae are found near the base of the limestone, particularly on the right bank of the river, 900 yards from the entrance to the gorge, and above a waterhole against the cliff. The limestone range rises to 400 feet above the creek bed here. The fossils are thick in a bed three feet wide, and the beds may be followed right across and up the cliff to the crest. The fossils are well preserved and unmistakable, comparing favourably with Taylor's type specimens from the Flinders Ranges, which are in the Tate Museum of the University of Adelaide.' *Archaeocyathus* is the commonest genus. The fossils are in part silicified, and surface specimens show them standing out in white quartz on the darker limestone. Other conical-cylindrical forms, with cone-in-cone structure, are determined as the conulariid *Salterella,* a common Australian Cambrian form, found associated with Archaeocyathinae in South Australia. Laminated algal growths are also associated with the Archaeocyathinae.

The river takes a short right-angled turn to the east soon after entering the limestone, and then passes south again through an impressive gorge in the limestone, at the "Goat Camp." The limestone rises almost sheer at this point, and the beds at the base of the cliff are at the top of the fossiliferous horizon. The limestone is "mottled," a feature characteristic of the South Australian Cambrian, attributed to algal growths by Sir Douglas Mawson (22), and referred to in a paper by the author on Conulariids below the Archaeocyathinae limestone in South Australia (23). In the "mottled" limestone at the base of the cliffs at the "Goat Camp," *Salterella* occurs in the darker, more calcareous lenses. Other unrecognisable fossil fragments and traces are present. The strike at the "Goat Camp" is east and west, and the dip 37° S.

The limestone beds are 3,500 feet thick, with little variation in their

massive texture. To the west the Cambrian limestones do not form ranges, but occupy lower ground, in the Glen Helen Valley, being dominated by the No. 3 and No. 4 Quartzites; but here the reverse is the case. In the Ross Gorge the lower beds are "mottled" and streaky, passing upwards into white to pink marble, bluish marble, and finally very distinctly yellow limestone at the top. The yellow beds were like those in the Waterhouse Range, but strangely no algal formations of the *Cryptozoon* type were seen in the whole exposure in the Ross Gorge. These are so conspicuous as to be found without difficulty when present, but time did not permit of a close examination of the whole of this great limestone mass.

The dip in the limestone increases to 40°, when the gorge opens out to a wide flat, in which the well is situated. On the right bank, as the flat is entered, a syncline is seen, composed of the basal Larapintine (Ordovician) beds overlying the yellow Pertaoorrta limestone. The syncline pitches west, and the quartzite is absent on the east side of the flat, on which side faint traces of possible Archaeocyathinae and algal forms were noted in the limestone. The Larapintine quartzite thickens to the west, as the syncline pitches, and it forms the western side of the flat, curving round to close in the flat on the south side, where the stream cuts through the Larapintine quartzite ridge. This ridge is again in synclinal formation. The flat is a weathered-down dome in the Pertaoorrta limestone.

Along the south front of the second synclinal ridge in the Larapintine quartzite the dip is northerly, and continues so as far as exposures go, out to the Todd Plain. The structure of the Fergusson Ranges is thus synclinal, with Larapintine remnants in the middle of the syncline.

Continuing south from the southern side of the well flat, a broad, flat valley is crossed, half a mile wide, in Pertaoorrta beds. There follow two distinct ranges in the Pertaoorrta limestone, and then the basal quartzite of the Pertaoorrta appears again, dipping 29° N. It makes a definite east-west range. Worm casts and sun cracks are common in the quartzite. In the section, the beds immediately overlying the quartzite, which contain the Archaeocyathinae at the Love's Creek end of the section, are weathered down, and exposures are poor. Faint fossil traces only were noted.

The ranges or ridges on the south side of the syncline have abrupt scarps to the south, and dip slopes to the north. The Pertatataka and Pertaknurra beds, underlying the last quartzite range, the base of the Cambrian, occur in more open country. They contain at least three low ridges in a sandy plain, one of which was thought to correspond to the base of the Pertatataka, but it was not the thick quartzite which occupies that position in other parts of the ranges. The most southerly ridge was 200 feet high, and crowded with the Chewing's *"Cryptozoön,"* in a yellow massive limestone. The bed corresponded to the *"Cryptozoön"* beds at Acacia Well, and is towards the base of the Pertaknurra. The dip here was 30° N., and lessening to the south, where a few low, scattered outcrops of limestone may be found in the plain, with duri-crust, and associated with the Arltungan beds. Across the Todd Plain the beds appear to be almost horizontal, and may be the basal quartzites of the Pertaknurra.

The section shows a synclinal structure, and a sequence of all the MacDonnell Range formations, namely, remnants of the Larapintine in the centre, and repeated outcrops of the whole of the Pertaoorrta each side, with the whole of the Pertaknurra and Pertatataka to the north, and the upper portion of those series to the south. The Heavitree Quartzite, the base of the Pertaknurra, is not repeated, unless perhaps south of the Todd. The beds are folded, but not greatly disturbed, with the exception of the Pertak-

nurra, which shows violent confusion at the north end of the section, near the contact with the Archaean shield. No angular unconformity is observable between any members of the series.

No attempt was made to go into the same detail as in the case of the Ellery Creek type section, but only to identify the series and ascertain their thicknesses and broader characters. The chief beds of the Ellery Creek section were readily identified, with the one exception of the No. 2 Quartzite, the base of the Pertatataka. Below are given the thicknesses and main character of the series in the two sections, the sections being parallel, and a hundred miles apart. The separation of the Pertatataka and Pertaknurra in the Ross section is uncertain, owing to poor exposures, and the thickness of the Pertaknurra only approximate, on account of the complexity of dip and lack of detail in the section.

Series.	Ross River Section.	Feet.	Ellery Creek Type Section.	Feet.
Larapintine (Ordovician)	Quartzites, calcareous and argillaceous flags, indefinite fossil moulds and worm casts, base of series only	300′	Quartzites, sandstones, narrow calcareous beds highly fossiliferous, with *Asaphus*, *Orthoceras*, *Raphistoma*, *Orthis*, etc.	5,986′
Pertaoorrta (Cambrian)	Purple basal quartzite, massive limestones, with Archaeocyathinae, Conularids, algal remains	4,100′	Purple basal quartzite, algal limestones, calcareous and arenaceous slates and shales, *Girvanella*	3,151′
Pertatataka (Newer Proterozoic)	Calcareous and arenaceous slates and shales, dense limestones and purple shales at top	2,030′	Basal quartzite and conglomerate, chocolate sandstone, quartzites, flags, oolitic limestone, purple slates	3,204′
Pertaknurra (Older Proterozoic)	Thick basal (Heavitree) quartzite, magnesian limestone, chocolate shales, massive algal limestones, calcareous and arenaceous slates	4,600′	Thick basal (Heavitree) quartzite, magnesian limestones, chocolate shales, massive algal limestones, calcareous and arenaceous slates	3,349′

The great similarity between the Adelaide Series and the Cambrian in South Australia, in the Mt. Lofty and Flinders Ranges, on the one hand, and the Pertaknurra, Pertatataka, and Pertaoorrta of the MacDonnell Ranges on the other, has been pointed out by the author in the account of the Western Ranges.

(h) The Gold Mines.

H. Y. L. Brown, in the publications cited, has described the gold mines in the Eastern MacDonnells, and there is little to add to his reports, except to place the auriferous formations in their proper position in the geological sequence.

The gold all occurs in the basal beds of the Pertaknurra, the Heavitree Quartzite, and chiefly in the Bald Hill—Mt. Laughlen—Mt. Gordon Range, and in the White Range, a portion of the Mt. Benstead virgation to the south of Paddy's Hole Plain, but almost in the line of the first range. In the neighbourhood of Bald Hill, the gold is in narrow quartz veins in the quartzite. The veins are short and irregular, and are characterised in all places by containing much pyrites in large cubes, which is often completely weathered out in the upper zones, making the quartz cellular and full of iron-stained and cubical cavities. The "fines" from mining the quartz are always rich. The gold is associated with the pyrites, and specks may be seen in the cavities when the pyrites is gone.

At Winnecke, most veins are in the quartzite. The first discovery was in a decomposed slate hill, a bed overlying the quartzite, which carried good values in its gossan capping, but was practically barren below, no values being found in the quartz reefs. The hill had weathered almost to kaolin, and was tunnelled through with pick and shovel, to no purpose.

Many small reefs are scattered about east of Mt. Gordon.

At White Range, where most work has been done, the quartzite dips at 15° E.N.E., the dip steepening up as the quartzite plunges into the gneiss at the foot of the range. Interesting water-eroded gulches run down the dip slope of the White Range at the mines. They are 10 or 12 feet deep, and 20 or 30 feet wide, with vertical sides, in the hardest of flinty quartzite, indicating the great age of these slopes, for the gulches are only a few hundred yards long, and the catchment so small. Some of the workings open off these gulches. The quartzite is here white and flinty, and it is hard to distinguish the quartz reefs and veins from the quartzite, all of which has been affected to some extent by the invading siliceous solutions.

The reefs are cellular and vughy, and the miners followed the cellular belts in the quartzite, which were always the richest. The lodes dip southerly and trend east-south-east, the shoots running south-east down the lodes. The lodes may be described as a stockworks, with the quartz in veins and joints. The ore was hand-picked by native labour, often screened, and the selected material averaged about 30 dwts. to the ton, though some parcels went up to 2 ozs. Mining of that sort would never pay with white labour for the returns obtained. Recently syndicates have been considering the mining and treatment of the whole mass of quartzite, of which there is certainly an unlimited quantity, but it is doubtful if a bulk assay would show a pennyweight. The battery returns are still in the office at the Arltunga battery, where they show little signs of their twenty years of solitude.

Alluvial gold shed from the reefs in these localities is still sought at intervals, usually by men employing native women. The returns are very small.

No extensive auriferous reefs have been found in the Arunta Complex itself, a curious fact. Some of the small shows north of White Range may be in the Complex. They were not examined. The best places to prospect are the Arunta Complex area, and particularly the contact of the Pertaknurra beds with the Arunta Complex. The northern border of the Jervois Range is such an area.

(i) The Area South of the Todd Plain.

The country south of the MacDonnells, lying east of the telegraph line and railway, and bordered to the east by the sand ridges of the Simpson Desert, has never been examined geologically from the ground. The author made several aeroplane flights in the area in 1929, and the following notes were made on those flights.

South of the MacDonnells, the Todd flows easterly in a plain 10 to 12 miles wide, bordered to the south by rough tableland country. The Todd turns south-east at the Giles confluence, skirting round the east end of this rough country, which continues inside the curve of the river for a distance of 80 miles south-east from Mt. Undoolya. The country becomes more open as Mt. Undoolya is left behind, till at 80 miles the last ridge is seen, followed by flat sandhill and claypan country, in which the Todd flows for another 50 miles before flooding out, with the Hale, in the Simpson Desert. The ridges in the area run at right angles to the Todd, where it runs S.E., that is, they trend about E.N.E.—W.S.W. There are six main and conspicuous

ridges, chiefly in the form of tableland, or more properly questa, edges, facing south-east. The dips are all to the north and north-west, and in most cases quite gentle. The beds are practically horizontal in the southern part of the small northern portion of the area under consideration, which is shown on the map herewith. The trend of the country is in conformity with that of the ridges in the main range between Mt. Undoolya and Acacia Well.

As seen from the air, the ridges appeared to be of quartzite, with limestone forming the lower areas, and in some cases showing clearly, underlying quartzite cappings, as white slopes in front of the questa edges.

The Ross River Section ended in Pertaknurra limestones, with a gentle north dip, and looking across the Todd, the tablelands to the south were seen to be of almost horizontal beds, with small northerly dip. It thus seems assured that the formations in the portion of the area shown on the map are of Pertaknurra age, and from the uniformity of northerly dip it seems likely that the Pertaknurra extends right to the plains to the south. The James Ranges and their easterly extension to Deep Well on the telegraph line, and the Ooraminna Ranges lying across the telegraph line, consist of rocks near the top of the MacDonnell Series, the Larapintine and Pertaoorrta, and the ridges to the east of the telegraph line should be a continuation of these ranges, but the indications are that to the east the older series are exposed. The fold axes in the area all pitch westward, which is in favour of this supposition. Limestones were too much in evidence for the Larapintine Series, which consist almost entirely of quartzites and sandstones. There is possibly no extensive area of Larapintine sandstones to the east of the telegraph line, corresponding to the James Ranges to the west.

Across the Todd to the east, the country is flatter, with only two conspicuous ridges, which are shown on the map, between the Todd and the Hale, and scattered smaller and isolated ridges in the plain. On the west side of the Hale there is some flat tableland country, indicated on the map, which ends just off the map to the south. The border of the plains east of the Hale is conventionally indicated on the map, but only scattered ridges exist in that direction.

VI. History and Tectonics.

The palaeography of the MacDonnell Ranges was outlined in the author's paper on the Western MacDonnells, written in 1931, but not yet published by the Geological Society of London. Further work has tended to confirm the views there expressed, and has extended some of the invading seas without affecting the general scheme. The palaeography will be briefly repeated here, with the addition of the added knowledge gained on the further expedition into the Eastern MacDonnells. The main ideas expressed in the earlier paper are in general agreement with the historical review, as far as it touches upon Central Australia, in the Explanatory Notes by Sir Edgeworth David to accompany his New Geological Map of the Commonwealth, which has since appeared.

The Archaean formations, the Arunta Complex, form a portion of the great Archaean shield of Western Australia, an easterly-projecting tongue, bounded to the south, east, and north-east by more unstable areas. The MacDonnell and Harts Ranges form the southern border of this tongue, which takes a north-easterly turn to the east, and against this border the younger formations, marginal to the shield, have been crushed and buckled by thrusts from the warpings of the basins in which they formed. The country to the west and north-west of the MacDonnells, mainly desert plains, has received little geological attention, but it appears that no more than a veneer of younger rocks at most overlies the Archaean in that direction. It

will probably be found that marine and terrestrial deposits of the Permo-Carboniferous (Kamilaroi) basin extend in from the direction of Broome, on the north-west coast of Western Australia, further than at present indicated, linking up with the possibly fluvio-glacial sandstones and conglomerates of Mt. Udor and the Missionary Plains, in the Western MacDonnells, and the conglomerates of the Townsend Ranges. At any rate, whatever remnants of younger formations may be found on the shield itself, it is certain that the main deposition of the younger beds took place round the margin of the shield in Central Australia.

The gneisses of the Arunta Complex belong to the unrecoverable history of the past. They may be included in the Yilgarn Division of Sir Edgeworth David, of Archaean age. The Pertaknurra Series, overlying the gneisses, presents the usual difficulties of ancient unfossiliferous sediments. The basal beds include over a thousand feet of quartzite, followed by another thousand feet of algal limestones, with some intercalated shales. The beds indicate shallow water conditions, a characteristic of all the Central Australian formations. The Pertaknurra beds are mainly marginal to the shield, but are now known to be included as remnants in the Arunta Complex, the quartzite only being so far recognised within the ranges in the Western MacDonnells, but the limestone, highly altered, appears in the east with the quartzite.

The Pertaknurra has definitely been intruded by granites, and is auriferous. None of the later series have been so intruded, and no remains of them have been found inside the borders of the ranges. The orogenic movements which disrupted the Pertaknurra, and engulfed part of it in the Arunta Complex, preceded the deposition of all younger formations. The basal beds of the Pertatataka Series contain boulders of the Aruntan and Pertaknurra, showing a long interval between the Pertaknurra and Pertatataka. For these reasons the Pertaknurra is placed amongst the oldest of Australian sediments, and assigned to the Older Proterozoic, and correlated with the Mosquito Series of Western Australia. In Sir Edgeworth David's Explanatory Notes, the Pertaknurra is correlated with the Adelaide Series, Newer Proterozoic, but the evidence now accumulated, and outlined above, indicates a greater age. The Pertaknurra is especially comparable with the Ashburton beds, a distinctive horizon of the Mosquito Series, well developed at Coorara in Western Australia, where dolomitic limestones of great but unknown thickness extend for 70 miles, with a 40° to 60° dip. They are invaded by granite. As the Pertaknurra is thin or absent to the west and north of the MacDonnells, we may assume that deposition took place in the Amadeus Strait of Sir Edgeworth David, which he first postulates in connection with the Nullagine (Newer Proterozoic) formations. Pertaknurra time closed with the greatest revolution which has ever affected the MacDonnells. The thinner portions of the Pertaknurra overlying the continental shelf of the Archaean peninsula of the MacDonnells were broken up, faulted, and fractured, and partially absorbed into the Aruntan, the process assisted by granite intrusions, seen today particularly in the Mt. Sonder area, at Alice Springs, Winnecke, Harts Ranges, and Western Jervois Ranges area. The thicker marginal beds were crushed and steeply tilted. This was a time of great granite intrusion in Central and Western Australia, and a most important metallogenetic epoch.

Sea invasions succeeded, and the following series are all shallow water, marginal to the shield, and conformable, separated only by less violent epeirogenic oscillations. The only obvious unconformities are those of the Pertaknurra on the Arunta Complex, and of the Pertatataka on the Pertaknurra, the latter indicated by the boulders of Pertaknurra in the basal Pertatataka conglomerates.

The Pertatataka includes sandstones, quartzites, and shales, with oolitic and algal limestones, and green micaceous slates, the limestones towards the top. The upper beds are dominantly red. This series bears a striking resemblance to the Adelaide Series, with which it is confidently correlated, and is placed in the Newer Proterozoic. There is also a strong correspondence with the Nullagine Series of Western Australia, but an absence of the volcanic phase of that series. The basal conglomerates of the Nullagine and Pertatataka Series are comparable, and the Carowine dolomites of the Oakover River and Hamersley Range of Western Australia, the calcareous phase of the Nullagine, may be compared with the Pertatataka limestones. The Nullagine dolomites are 300 feet thick, with bands of chert and jasper, and are overlain by arenaceous beds.

The Pertatataka (Nullagine) seas were very extensive. They stretched from the MacDonnell Ranges southward to cover most of South Australia, and eastward to an unknown distance. No evidence of a glacial period, to correspond with the Sturtian tillites of the Adelaide Series, has been found, though this was specially sought in the Western MacDonnells. The basal beds of the Nullagine, in lower latitudes, are doubtfully placed as fluvio-glacial, but the highlands shedding the ice responsible for the Sturtian tillite appears to have lain to the far south-south-west of the MacDonnells, in the neighbourhood of the present Gawler Ranges in South Australia.

The Pertatataka formations pass upwards through red and purple beds into a tremendous thickness of limestones, the Pertaoorrta (Cambrian). The red passage beds are the almost exact equivalent of the Purple Slate Series at the top of the Adelaide Series. The Pertaoorrta limestones are over 3,000 feet thick in the Ross River section, a much greater thickness of limestone than known in the Adelaide Series.

The easterly-extending bulge of the Australian shield projected into Cambrian seas bounding it on the north, east, and south. Southward the seas extended right across central South Australia. The Amadeus Strait, which subsided deeply in Cambrian times, was open to the south.

The Ordovician seas were somewhat similarly disposed as regards the Central Australian massif, but do not appear to have encroached upon the land to the north-west of the shield, from which the Cambrian seas had drained, as Ordovician deposits are absent from Western Australia and North Australia. The author considers the beds west of Lake Torrens to be in part Ordovician, and also formations on Kangaroo Island (24) which contain boulders of Archaeocyathinae limestone. These beds are a shore facies, and indicate a meridional shore line from the MacDonnell Ranges down the centre of South Australia, the seas deepening to the east of this line. The shallow water facies of the Ordovician (Larapintine) in Central Australia is most marked. These beds have now been determined to the north of the Harts Ranges, showing an extension of the seas to the north-east of the MacDonnells, to an unknown limit.

After the retreat of the Ordovician seas, a period of peneplanation set in, in Central Australia, which continued unbroken till the close of the Palaeozoic Era. During the Carboniferous and Permian, periods of great epeirogenic and orogenic movements in Australia, with the formation of high ranges, intense glaciation, and intermittent sea encroachment, Central Australia once more took a part in world events. Seas encroached from the north-west, into the great Desert Basin of Western Australia, and also possibly from the Great Australian Bight in the south-west. It is probable that the thrusts from the Pacific raised the MacDonnells, the marginal formations to the central shield, once more to imposing heights, their last important elevation. Erosion

during the pluvial times formed the great Post-Ordovician conglomerate, 9,000 feet thick, which the author previously correlated with the Finke River Series, and assigned to a Permo-Carboniferous age, the conglomerate being regarded as a flysch series, with no ice action evident near the ranges, but only further to the south. This great thickness of conglomerate is only found forming the southern foothills of the Western MacDonnell Ranges, and is completely absent to the east of the telegraph line. This indicates a drainage to the west and south-west from the MacDonnells at the time of the formation of the conglomerates, and the Permo-Carboniferous seas are the only known Post-Ordovician seas of epeiric extent in those directions... It is considered that all the flat-topped sandstone and conglomerate hills on the shield to the west of the MacDonnells may be dated to these times of fluvio-glacial deposits. The Post-Ordovician (Pertnjara) conglomerate may thus be correlated with the Wallarobba, or more probably the Lyons conglomerate.

The MacDonnell Ranges must have been almost base-levelled at the close of the Palaeozoic, and the Triassic and Jurassic lacustrine conditions of the Commonwealth left no permanent records in Central Australia, with the possible exception of derived fossil plant remains in the Arltungan beds, which thin and scattered mesa-like remnants of terrestrial deposits, not exceeding 100 feet in thickness, represent the total effects of deposition in Central Australia during the Mesozoic and Tertiary, during which time the shield had remained stable.

The great sea transgression of the Cretaceous did not reach Central Australia. The Great Artesian Basin crosses the south-eastern corner of the territory, the Simpson Desert, 150 miles from the MacDonnell Ranges. The effects of the Laramie Revolution, however, appear to have been felt in the MacDonnells. The outward thrust from the oscillating floor of the Great Basin buckled the range area against the shield for the last time, folding the Ordovician beds into gentle undulations in the James Ranges. The folding increases in intensity towards the shield margin, where the dip becomes steep and everywhere southerly, to the west of the telegraph line. A syncline developed all along the southern front of the main MacDonnell Ranges, from the centre of the Fergusson Ranges, through the Emily and Missionary Plains to the far west. The axis of this important fold pitches westward, and the basin deepens to the west. The Ordovician (Larapintine) is represented by basal remnants only in the Fergusson Ranges, 300 feet thick, but increases to a thickness of 6,000 feet in the longitude of Ellery Creek. This further indicates depression to the south-west of the MacDonnells in late Palaeozoic times, when the folding of these beds probably commenced.

The Larapintine beds to the north-east of the MacDonnells have suffered little disturbance, and are considerably thinner. They dip gently northward, and are a shallow-water veneer on this portion of the shield.

The elevation of the MacDonnells in Cretaceous times probably re-introduced glacial conditions.

The beds from the Pertatataka (Newer Proterozoic) upwards, show no conspicuous faulting, but only east-west folding, to the south of the main ranges. The basal beds of the Cambrian, the remarkably constant red range of No. 3 Quartzite, form a ridge 150 miles long, broken only by minor gaps east of Undoolya Gap, which were not closely inspected, but gave the impression of being lateral displacements by faulting.

The drainage has been southerly off the shield margin at least since the Ordovician sea invasion, and the drainage lines of today are of extreme antiquity. Erosion has continued without interruption throughout Tertiary and Quaternary times, as conditions have gradually changed from pluvial to arid, till now only the

quartzite ridges stand up in parallel lines, cut across to depths of a thousand feet by transverse streams fed by the lateral valleys in softer beds. The lateral valleys are now base-levelled to the main streams as narrow plains between the ranges.

To summarize, the MacDonnell Range area consists of a tongue of the Archaean Shield of Western Australia projecting into Central Australia. This tongue, widening to the north-west back into the shield, carries only thin remnants of formations younger than the Archaean, and principally Permo-Carboniferous fluvio-glacial beds, which remain horizontal. The tongue is surrounded on the north-east through east to south, by formations of Pertaknurra (Older Proterozoic), Pertatataka (Newer Proterozoic), Pertaoorrta (Cambrian), and Larapintine (Ordovician) age, which everywhere dip off the older rocks.

Apart from the history of Archaean times, the first important revolution was at the close of the older Proterozoic, when the Pertaknurra beds, mainly marginal to the shield, were greatly disturbed and partially incorporated in the Archaean. It was a time of mountain-building and granite intrusion. This revolution was followed by quiet deposition, in shallow Newer Proterozoic, Cambrian, and Ordovician seas, in the depressions round the tongue. Gentle epeirogenic uplift put an end to this shallow water deposition, and the next marked change came in the late Palaeozoic disturbances, when the MacDonnell Ranges were again elevated, fluvio-glacial conditions were imposed, and the great Pertnjara conglomerates were formed. This was the last grand elevation of the MacDonnells. During the Mesozoic, the gradually eroded ranges supplied the sands of the great artesian basin lying to the east and south-east.

At the close of the Mesozoic, outward thrusts from the Great Basin gave the final uplift to the MacDonnells, since when erosion has continued unbroken, with a southerly or south-easterly drainage off the shield.

The sinking of the Lake Eyre Basin in Pleistocene times rejuvenated the streams flowing out of the ranges, assisted possibly by some compensating rise of the range area, and the terrestrial deposits in the valleys of the ranges were incised to a depth of 50 feet or so, leaving the Arltungan beds as remnants of those deposits.

VII. The MacDonnell Ranges Fossil Fauna and Flora.

(a) The Algal Limestones of the Pertaknurra, Pertatataka and Pertaoorrta.

The limestones in the above formations are crowded with what appear to be organic growths. These structures were all ascribed to calcareous algae by Sir Douglas Mawson and the author in 1930 (25). One variety, the commonest, was first discovered by Chewings, and, determined by Howchin *(loc. cit.)* as *Cryptozoön*, in 1912, since when the limestones have been generally referred to as the *Cryptozoön* limestones. Sir Douglas Mawson and the author first drew attention to the grand development of these forms through thousands of feet of limestones, and in the paper quoted, several types were illustrated. Since then the author has examined the limestones in greater detail, assigned them to their respective series, and collected extensively. The forms are still not generally accepted as of algal origin, and the author is not yet prepared to attempt a final word on the subject, but the following additional notes are put forward as an interim report.

The forms, referred to in the preceding pages as stromatoliths, are found in early and late Pre-Cambrian and Cambrian beds, in the latter associated with Archaeocyathinae. Particular types of growth are absolutely characteristic of certain horizons throughout this great succession of series, a strong point in favour of an organic origin, and this in localities a hundred miles apart. Again, these corresponding horizons contain the same type of stromatolith, whether they be in steeply folded and contorted strata, or horizontal beds, which is against any mechanical theory of origin.

The forms fall into at least seven distinct classes:—1. *Cryptozoön*-like. 2. Ellipsoidal. 3. Large platy masses. 4. Laminae in festoons. 5. Dendritic. 6. Ball-like, similar to *Girvanella*. 7. Large circular biscuits.

They are given in order of relative abundance.

The *Cryptozoön*-like forms are commonest, and specially characteristic of the lower limestones of the Pertaknurra, where Chewings first found them. Their dimensions are some five inches long by half to three-quarters of an inch in diameter, cylindrical and tapering downwards, with laminated structure, the laminae definitely and invariably convex upwards. *Cryptozoön* (Hall) was described by the founder of the genus as having the laminae concave upwards, which feature Walcott regards as a *sine qua non* of the genus. Hall's *Cryptozoa* are up to two feet in diameter, much larger than the MacDonnell Range forms, which in general appearance exactly resemble the forms found in the Carboniferous Tuedian beds of Cumberland, figured by Garwood (26) in his pl. vii., fig. 1, except that the latter are figured as concave upwards. Bigot (27), in his papers on the Cambrian of Carteret, shows similar forms in his fig. 13, occurring in estuarine deposits with oolitic structure, and associated with Archaeocyathinae under exactly similar conditions to those obtaining in the Cambrian of the MacDonnells. Bradley's work (28) throws great light on the algal reef problem. Bigot's three classes of algae, and most of the MacDonnell forms, have their counterpart in the growths of *Chlorellopsis coloniata* (Reis) in the Eocene algal reefs of the Green River formations, as far as general appearance, as distinct from microscopical structure, is concerned. This last work indicates that the classification of algae on the shape of the colonies, in the method of Walcott, is unsound, but that the ascribing of these ancient structures to algal growths seems obvious and unavoidable. In forms similar to Bradley's *Chlorellopsis* colonies, Garwood finds *Bevocastria, Mitcheldeania,* and sometimes *Girvanella* or *Ortonella.* The cell-structure appears to be the only certain distinguishing characteristic of the algae.

The algal reefs of the Belt Series of Montana, described by Walcott, particularly those of the Algonkian Newland limestone, contain forms exactly corresponding to some of the MacDonnell Range examples. Walcott's *Collenia prolifica* may be compared with the MacDonnell Range *Cryptozoön,* and his *Newlandia concentrica* with the ellipsoidal forms of the MacDonnells. Walcott does not recognise *Cryptozoön* below the Cambrian, and the works referred to appear to throw doubt on the soundness of this genus. The MacDonnell Range "*Cryptozoön*" differ from the type examples of the genus in direction of convexity of the laminae, and very greatly in size.

While convinced, on the grounds indicated above, of the organic origin of the stromatoliths of the MacDonnells, and strongly in favour of the algal reef theory on the available evidence of definitely determined algal forms, the author considers that any attempt to classify the algae which gave rise to these colonial forms must depend on cell-structure determined under the microscope, which structure has so far been found lacking or obscure in the MacDonnell Range examples, though more intensive study may yet reveal it.

No other organic forms have been recognised in the Pre-Cambrian (Pertaknurra and Pertatataka), except apparent worm casts and obscure oval impressions in the basal quartzites, but the Cambrian, in addition to the algae, is rich in Archaeocyathinae and Conulariids, with possibly Trilobite fragments in the MacDonnells. The Archaeocyathinae were found only in the Fergusson Ranges, in the Ross River section, where algal forms were inconspicuous, and indefinitely near Oorobbra Rockholes. In the Waterhouse Ranges the Pertaoorrta (Cambrian) is rich in dendritic algal forms, also *Girvanella* (?). The basal quartzites everywhere contain what appear to be bivalve impressions, and worm tubes and casts are common.

(b) The Larapintine (Ordovician) Fauna.

In the Eastern MacDonnell Ranges the Larapintine is represented by arenaceous beds only. No recognisable fossils were found in the Fergusson Ranges, but at Hückitta Station, near Mt. Ultim, in the tableland country, fossils are numerous but ill-preserved. *Orthis* is there common, and at Mt. Ultim *Pleurotomaria,* with Trilobite fragments indefinite.

The Larapintine fauna in the Western MacDonnells was described at length by Tate in the records of the Horn Expedition (15), and Tate's types are preserved in the Tate Museum of the University of Adelaide. Tate's fossils came mainly from the James Ranges in the neighbourhood of Tempe Downs, though there was some confusion as to localities. It appears from the narrative that only moulds in quartzite were found in the Horn Valley, at, and west of, the Finke River. The author in 1930 collected extensively in the limestone horizon of the Larapintine, in the Horn Valley where it is crossed by Ellery Creek, and also in the Boggy Hole Creek in the James Ranges, both new fossil localities. Miss E. M. Turner, B.Sc., has since worked through this collection and identified most of the species listed by Tate. In addition, she has called attention to several forms not so far known in the Larapintine, in the genera *Isoarca, Orthoceras, Actinoceras,* *Endoceras*, and the Trilobite family, and has discussed their affinities, in addition to recognising for the first time in the Larapintine, *Murchisonia, Orthoceras procerus, Endoceras festans* (Blake), *Bathmoceras* (Barrande), *Ampyx,* and a member of the family Olenidae. The author is much indebted to Miss Turner for carrying out this arduous and detailed work, which is deserving of publication in full.

Below follows a catalogue of Larapintine fossils, which includes Tate's list, and Miss Turner's identifications from the author's new localities, with Miss Turner's additional genera.

CLASS BRACHIOPODA.

Orthis leviensis (Eth. fils). Very abundant. Loc. Horn Valley at Ellery Creek, Tempe Downs, Boggy Hole Creek, Mareenie Bluff.

Orthis dichotomalis (Tate). Very abundant. Loc. Horn Valley at Ellery Creek, Tempe Downs, Mareenie Bluff.

CLASS LAMELLIBRANCHIATA.

Isoarca crassatellaeformis (Tate). Loc. Limestone, Boggy Hole Creek; quartzite, Finke Gorge; numerous in quartzite, Mt. Watt.

I. etheridgei (Tate). Loc. Horn Valley at Ellery Creek, Tempe Downs.

I. castii (Tate). Loc. Sandstone and quartzite below fossiliferous limestone, Tempe Downs.

I. corrugata (Tate). Loc. Very abundant Middle Valley, Tempe Downs; also Ilpilla Gorge.

I. orbicularis (Tate). Loc. Abundant in quartzite, Mt. Watt.

I. opiformis (Tate). Loc. Quartzite, Petermann Creek and Tempe Downs.

I. wattii (Tate). Loc. With *I. opiformis.*

Palaearca wattii (Tate). Loc. Quartzite and sandstone. Tempe Downs and Finke Gorge.

P. tortuosa (Tate). Loc. Quartzite, Mt. Watt, Petermann Creek, and Tempe Downs.

Pteronites micans (Tate). Loc. Limestone, Tempe Downs.

Conocardium, Sp. Loc. Limestone, Tempe Downs.

CLASS GASTROPODA.

Raphistoma brownii (Eth. fils). Loc. Horn Valley at Ellery Creek and Finke Gorge, Tempe Downs.

Ophileta gilesi (Eth. fils). Loc. Horn Valley at Ellery Creek, Tempe Downs.
Eunemia larapinta (Tate). Loc. Boggy Hole Creek, Tempe Downs.
Scalites (?) eremos (Tate). Loc. Tempe Downs.
Pleurotomaria (?) larapinta (Tate). Loc. Boggy Hole Creek, Tempe Downs.
Murchisonia, Sp. Loc. Quartzite, Horn Valley at Finke Gorge.

CLASS CEPHALOPODA.

Orthoceras microlineatum (Tate). Loc. Horn Valley at Ellery Creek, Tempe Downs.
O. gossii (Eth. fils). Loc. Tempe Downs and Petermann Creek.
O. ibiciforme (Tate). Loc. Tempe Downs and Petermann Creek.
O. larapintense (Tate). Loc. Limestone, Tempe Downs.
O. chewingsi (Tate). Loc. Limestone, Laurie Creek, Petermann Creek, Tempe Downs.
Endoceras warburtoni (Eth. fils). Loc. Limestone, Laurie Creek, Tempe Downs, Petermann Creek.
E. arenarium (Tate). Loc. Quartzite immediately underlying limestone at Tempe Vale and Finke Gorge.
Actinoceras tatei (Eth. fils). Loc. Very abundant, Horn Valley at Ellery Creek, Laurie Creek, Tempe Downs, Petermann Creek, Mareenie Bluff, Chandler Ra.
Trochoceras recticostatum (Tate). Loc. Single specimen, Laurie Creek.
Bathmoceras (Barrande). Loc. Horn Valley at Ellery Creek.

CLASS CRUSTACEA. ORDER TRILOBITA.

The Trilobite remains in the Horn Valley at Ellery Creek are very abundant. Three genera are represented:—*Asaphus, Ampyx,* and *Angelina* (?), and fragments of all three are found on all specimens, thickly covering both sides of thin slabs of limestone. Even where the *Orthis* or *Ophileta* are dominant, Trilobite fragments are numerous. *Asaphus* is represented by forms from the smallest to specimens 25 cm. in length, and is the commonest genus. The very abundance and intermixture of the well-preserved fragments makes the allotting of each piece to its proper genus a difficult problem.
Asaphus illarensis (Eth. fils). Loc. Horn Valley at Ellery Creek, Tempe Downs, Mareenie Bluff, Petermann Creek. Two entire specimens obtained.
A. lissopeltis (Tate). Loc. Horn Valley at Ellery Creek, Laurie Creek and Petermann Creek.
Ampyx cf. A. nudus (Forbes). Loc. Horn Valley at Ellery Creek.
Olenidae cf. Angelina (Salter). Glabellae particularly in great numbers, associated with *Ampyx* and *Asaphus*. Loc. Horn Valley at Ellery Creek.

CLASS ECHINODERMATA.

Several small stem segments of Crinoids. Loc. Boggy Hole Creek, Tempe Downs.

CLASS ZOANTHARIA.

Two indeterminate species of coral (Tate). Loc. Middle Valley, Tempe Downs, and George Gill Range.

(c) The Arltungan.

The Arltungan formations have been fully discussed above. The organic remains so far obtained from these beds are listed below:—

Planorbis cf. P. hardmani. Loc. Limestone, Paddy's Hole Plain, near Arltunga.
Corbicula (?). Loc. Freshwater limestone, Claraville Plain.
Chara (?). Loc. Freshwater limestone, Claraville Plain.
Osmundaceous Stems. Loc. Paddy's Hole Plain, near Arltunga.
Silicified tree trunks. Loc. Plain in Waterhouse Ranges.

VIII. Botanical Notes.

While making no pretence to systematic botanical observations, the author noted the common types of trees. These notes may be of interest to those engaged in the study of plant and soil distribution.

The Todd Plain is sparsely wooded, clumps of gidgee *(Acacia Cambagei)* being the most conspicuous tree. This timber appears to be characteristic of the Simpson Desert to the south and south-east of the area of the map. Winnecke mentions it frequently as occurring along the Queensland—Central Australian border. It is more common there than mulga, apparently. To the west of the telegraph line, on the Emily and Missionary Plains, which are the same topographical feature as the Todd Plain, the tall mulga is the dominant tree, and no gidgee was seen there, nor anywhere to any notable extent west of the telegraph line. Gidgee was noted in one patch in the Love's Creek Valley, on the west of the station, also sparsely on the Plenty Plain, but in some thick clumps near the Marshall on the outward track. It appears to favour sandy areas and always the plains.

Mallee *(Eucalyptus,* sp.) was unexpectedly found in a small wood of several acres in the Love's Creek Valley. It also occurs abundantly on Paddy's Hole Plain, and grew to the exclusion of all other trees in the Arltungan limestone area in the Hale Plain, north of the river, between Ambalindum and Claraville Stations. In the latter area the trees were equal in development to those of the mallee plains of South Australia. All the areas mentioned are highly calcareous, the mallee clumps in the Paddy's Hole Plain indicating the Arltungan *Planorbis* beds. No mallee was seen north of the Harts Ranges.

The only saltbush seen was the large variety known as old man saltbush *(Atriplex nummularium)*. It grows in the Love's Creek Valley, round the station only, and in the Hale Plain, which is locally called the "saltbush plain," indicating the rarity of saltbush in Central Australia, that its presence should be a distinguishing feature of an area. Saltbush was only noted in these two places.

In the Harts Ranges the variety of trees is greater. Mulga occurs on the clay flats throughout the whole region, and is by far the commonest tree, with ironwood *(Acacia salicinia)*, or desert willow, the most picturesque tree of the region, next in order of abundance. In the ranges there are, in addition, various eucalypts, native figs, and the bean tree *(Erythrina vespertilio)*. The last-named interesting tree, with its scarlet beans, is very common in all creek beds as they enter the Plenty Plain, on the northern watershed of the Harts Ranges. They are not found out on the plains, but only along the foothills. The "Marked Tree" is a bean tree.

The plains north of the MacDonnell and Harts Ranges are essentially mulga plains, the tall variety *(Acacia aneura)* being the dominant type, but the more bushy kinds are also common. The desert willow or ironwood is next common, and the cork bark *(Hakea lorea)* frequent. These plains are of red loam, and not sandy like the plains to the south of the map.

Spinifex or procupine grass *(Triodia irritans)* is very dense in the Simpson Desert, which may be described as a sea of spinifex, as observed on the aerial flights in this area, but in the ranges themselves it is not general, avoiding the valley floors, but flourishing on limestone ridges, and even on the quartzite ranges, and the more sterile slopes. It specially favours dry limestone outcrops, where it is universally found. The traveller in the ranges would scarcely notice the spinifex, but once an attempt is made to climb the hills, it becomes painfully obvious. It occurs with the mallee on the Arltungan rises in the Hale Valley, and on Paddy's Hole Plain. Other patches were seen between Bald Hill and Bond Springs, on limestone rises. It is quite scarce on the Plenty Plain.

No desert oak *(Casuarina Decaisnéana)* was seen in the whole area. This tree is common in the sandy plains and sandhills south of the ranges, particularly in the Depot Sandhills, along the railway line.

The watercourses everywhere are lined with eucalypts, the white, or whitewash gum *(Eucalyptus papuana)*, being very general in the ranges, with *E. rostrata* and *E. terminalis*, while the box gum *(E. microtheca)*, with its rough, dark bark, is more characteristic of the stream beds in the plains. Varieties of tea tree *(Melaleuca)* are common in the creek beds in the ranges.

IX. Summary.

The same series of formations have been found in the Eastern MacDonnell Ranges as described in the Western Ranges, with the exception of the Post-Ordovician (Pertnjara) conglomerate, namely, the Arunta Complex (Archaean); the Pertaknurra (Older Proterozoic), 4,600 feet of quartzites and algal limestones mainly; the Pertatataka (Newer Proterozoic), 2,030 feet of quartzite, calcareous slate and shales, algal limestones and purple slates; the Pertaoorrta (Cambrian), 4,100 feet of purple quartzite, shales and massive Archaeocyathinae and algal limestones; the Larapintine (Ordovician), 300 feet of quartzites, and calcareous and arenaceous flags; and Arltungan (Tertiary, Quaternary, and possibly in part Mesozoic beds), with maximum thickness of 100 feet, freshwater limestones, sands, clays, and conglomerates, with pronounced duricrust.

The Arunta Complex of gneisses, schists, and intrusive rocks, forms the main portion of the ranges, an easterly-extending tongue of the Great Shield of Western Australia, which is enclosed on the north-east, east, and south by the younger formations, which form marginal ranges, at first of steep dip, everywhere radial from the ancient gneissic shield, but gradually flattening out into gentle folds with distance from the main ranges. The only series that has shared in the later disturbances of the Arunta Complex is the Pertaknurra, portions of which are found faulted down into and partly digested by the Aruntan. This series has been intruded by the last granite invasions, but all later series are entirely marginal to the Aruntan exposures, and free from any effects of igneous activity.

The southern margin of the Arunta Complex formations lies at about the latitude of Heavitree Gap, curving north-eastward beyond Undoolya Gap, and then again eastward. South of the margin the younger series are found in orderly succession of outcrops, which is repeated owing to an east-west synclinal fold in the Fergusson Ranges, where the exposures are most complete. North of the line, the Arunta Complex extends for 85 miles to the north-east, to the Mopunga Range, including within it some remnants of the Pertaknurra in the neighbourhood of Winnecke Mines, Paddy's Hole Plain, and the Harts Ranges. Beyond the Harts Ranges, on the Plenty Plain, the Aruntan formations are poorly exposed in flat country, but granites and gneisses again form the ranges south of the Mopunga Ranges.

In the latitude of the Mopunga Ranges, the northern margin of the Arunta Complex, the sequence to the south of the main MacDonnells is repeated in its entirety, with northerly dips, and east-west strike, ending in flat tablelands of the topmost member of the series, the Larapintine (Ordovician). The section from the Mopunga to the Fergusson Ranges is thus in the nature of a huge unroofed anticline, with 85 miles of the core formations, the Arunta Complex, intervening between the repeated series of younger formations.

The only formations in the area younger than Ordovician are the flat-lying Arltungan beds, of terrestrial origin, unconsolidated except for duricrust, which are found as scattered remnants in all the main valleys. They have in the main a Pleistocene facies, but silicified plant remains and lignite suggest a greater age.

Erosion is considered to have been continuous in the ranges since the close of the Palaeozoic, and the Arltungan beds represent remnants of all alluvial deposits in the subsequent periods, the silicified plant remains probably representing derived fossils from older alluvium.

The mica occurs in the Arunta Complex in the Harts Ranges, and the auriferous country is confined to the Arunta Complex and the basal beds of the Pertaknurra.

There is no mineralization above the Pertaknurra.

X. Explanation of Plates, Text Figures, and Map.

Plate III.

Fig. 1. South-east view from a gully in the Pertaknurra limestone, a massive algal formation, across Acacia Well to the No. 3 Quartzite range and succeeding Pertaoorrta (Cambrian) beds. This is a typical view of Love's Creek Valley, bounded on the northern side by Pertaknurra limestones, and on the southern by the Cambrian (No. 3) quartzite. It was in this gully that Chewings first discovered "*Cryptozoön*." The well is hidden by a tree, but the line of troughing may be seen in the left centre of the valley. A smaller ridge of Pertatataka limestone may be seen across the valley, in front of the main Pertaoorrta (Cambrian) Quartzite range.

Fig. 2. Contorted Pertaknurra limestone in Bitter Springs Gorge.

Fig. 3. The Heavitree Quartzite, the base of the Pertaknurra Series, dipping down into Aruntan gneiss at White Range Mines. The quartzite is the white rock on the left, the gneiss forming the small dark cliffs on the right, with the creek course along the junction. The workings are just to the left of the observer, scattered over the hillside and out of view.

Plate IV.

Fig. 1. Larapintine (Ordovician) Quartzites occupying the trough of the syncline in Pertaoorrta (Cambrian) limestones on the Ross River.

Fig. 2. Pertatataka limestone with dip slope to the north, at the lower end of the Ross River Section. The spinifex on the limestone ridge is to be noted. This ridge corresponds to the limestone ridge in the north limb of the syncline beneath which Love's Creek Station lies, at the entrance to the Ross River Gorge. The No. 3 Quartzite makes a prominent parallel ridge just out of view to the left of the picture, just as it backs up the limestone at Love's Creek Station, and as shown in pl. III., fig. 1.

Fig. 3. The northern front of the Harts Ranges, west of Luce's Spring. The rounded topography of these gneissic hills is in striking contrast with the parallel ridges of the southern MacDonnell Ranges. Pegmatite dykes may be seen crossing each of the two foothill rises to the right. The mica occurs in these pegmatites all along the front of the range. The view is looking across the camp in the creek, shown on the map west of Luce's Spring, and is taken from a granite knoll.

Plate V.

Fig. 1. A scoop-hole in the sandy bed of the Entia Creek near its confluence with the Plenty River. The view is taken from the left bank of the stream, looking south across the stream to the opposite bank, marked by the line of trees. The sands are saturated with water at two feet below the surface, and water may be similarly obtained almost anywhere in the bed of the Plenty, which stream presents an exactly similar appearance, though even wider. The hole has been made by horses and scoops, but is only a large example of the hand-dug "soak."

Fig. 2. The large waterhole at the top of the string of Oorobbra Rockholes, in the Pertaknurra granite arkose. The resemblance of the arkose to a granite, in weathering and jointing, is to be noted.

Fig. 3. A southerly view over Huckitta Station from the top of the Larapintine (Ordovician) tableland. The little stream in the cleft makes a fine waterfall over the scarp to a pool below in times of rain. The Mopunga Range, beyond the invisible Marshall River, may be seen on the skyline. The top beds of the Larapintine, seen in the picture, are dense quartzite, dipping gently north.

TEXT FIGURES.

Fig. 1. Ross River Section. This section is described in detail in the text. The synclinal structure of the section is obvious. The folding is more intense than indicated, in the Pertaknurra beds close up to the Heavitree Quartzite at the north end of the section, where a crush zone is shown. The scale does not allow of greater detail at this point. The Archaeocyathinae horizon is indicated, and the scarp at the "Goat Camp."

Fig. 2. A section across the base of the Pertaknurra Series, three miles west of Grant's Bluff. The Oorobbra Rockholes arkose, flat and of wide extent at the Rockholes a mile and a half to the east, is here vertical. To the north the dip of the beds flattens towards the Larapintine tableland some four miles to the north.

Fig. 3. A section across the Jervois Range at Grant's Bluff. In this section the Pertaknurra arkose is gently folded and faulted, with overlying flaggy quartzite. The Oorobbra Rockholes lie half-way between the positions of the two sections, in a shallow syncline in the arkose. In both sections the arkose rests on granite and granitic gneiss, with quartz reefs, the Arunta Complex.

THE MAP.

A geological sketch map of the Eastern MacDonnell Ranges, from the telegraph line to the 136th meridian, and between latitudes 22° and 24° south, with a section from the Mt. Ultim tableland to the Todd River, 125 miles. The sources from which the map was drawn are given in the text, and the geology discussed. The south-eastern corner of the map is geologically unknown. It is an area of sandy plains, the north end of the Simpson Desert, and rock exposures are few.

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THE SOILS OF THE SOUTH AUSTRALIAN MALLEE.

By J. A. Prescott and C. S. Piper, Waite Agricultural Research Institute.

[Read September 8, 1932.]

Plate VI.

Introduction.

The mallee areas of South Australia have assumed considerable importance of recent years owing to their development as wheat-growing areas, particularly since the period 1906-1909, when the Murray Mallee and Eyre Peninsula were first opened up by railways. This development has been made possible principally through the introduction of a special technique in clearing the mallee scrub by means of rolling and burning, by the invention of "stump jump" farm implements, and through the extended use of superphosphate to which these soils are particularly responsive.

The term mallee, originally referring to the habit of growth of certain eucalyptus species, of which the most important are *E. dumosa, E. oleosa,* and *E. gracilis*, has acquired both in South Australia and in Victoria a definite geographical significance and has been used to name an important group of soils in southern Australia characterised by special features (Prescott, 1931).

The ecology of the mallee areas has been dealt with by Wood (1929), while Fenner (1930) may be consulted with respect to their position amongst the major physiographical features of the State. Howchin (1929) deals with the geological structure of the Murray Mallee.

From a farming point of view the mallee areas fall into three main divisions: Eyre Peninsula, Yorke Peninsula with portions of the Lower North of South Australia, and the Murray Mallee itself. The northern boundaries of development were for many years fixed by Goyder's line of rainfall (G. W. Goyder, 1866), although this line was not primarily determined in relation to the extension of wheat growing. This line, coinciding approximately with the southern limits of saltbush and blue bush, no longer represents the northern limit of wheat growing, and favoured localities such as Loxton, the country between Kadina and Port Pirie, and Kimba actually lie outside the line.

Statistical experience regarding the mean wheat yield and its variability has recently been summarised by Phipps for the Agricultural Settlement Committee (1931), and it is pointed out that beyond Goyder's line the variability of the seasonal rainfall becomes the principal factor controlling the possible yields of wheat.

Agricultural experience in the mallee areas and the response of the characteristic soils to fertilisers is well summarised in the reports of the Roseworthy Agricultural College, the Veitch experimental farm, and the Minnipa experimental farm.

Along the River Murray these soils are used extensively for the production of citrus and vine fruits under irrigation. Typical mallee soils at Renmark and Cadell have been described by Taylor and England (1929), by Marshall and Hooper (1932), and by Marshall and King (1932).

In defining the limits of these soils, use has been made of the records of native vegetation, and fig. 1 indicates the general extent of these soils. Wood (1929) points out that few communities can be recognised in the mallee so far as the main tree species are concerned. In addition to the eucalypts, the Murray

pine, *Callitris glauca* and the black oak or belah, *Casuarina lepidophloia*, are important, the former being especially characteristic of deep red sands or sandy loams such as the Murray sand.

The mallee habit is shared by a number of eucalyptus species with habitats outside the typical mallee soil areas; these include particularly the desert gum, *E. eudesmoides*, on the dry side, and *E. angulosa* and *E. diversifolia* on the wetter margin of the mallee. Wood (1930) has already discussed the special ecological relationships of the latter. The southern margin of the mallee soils has, therefore, been fixed in relation to the distribution of these latter indicator species, and of the survey records of the associated leached soils with white surface sands and

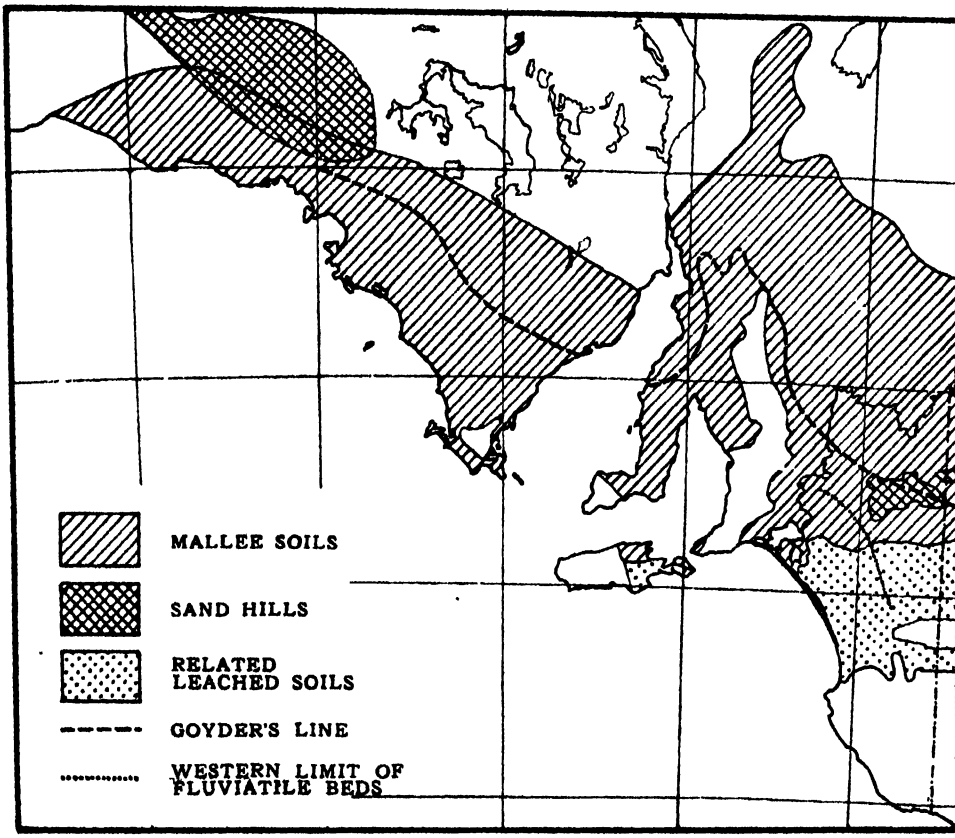

Fig. 1.
Map of portion of South Australia, showing the general geographical distribution of mallee and related soils.

yellow sandy clay subsoils over limestone or marls which appear to be characteristic of the "ninety-mile desert" and of the adjacent areas of "sandhills with heath" and of the "little desert" in Victoria.

These leached soils are definitely related to the mallee soils, but appear to be relatively poorer in plant nutrients and to have structural affinities with the "solodi" or leached solonized soils of the Russian system of classification. They have, therefore, been separated from the mallee soils to form a separate group.

In two areas high sandhills are of importance—these also have been indicated in fig. 1. They both occur to the north-east of exposed Miocene limestone formations, where travertine "hamada" surfaces are particularly common as in the

Nullarbor Plain and to the east of the Murray, almost as far as Karoonda. It has been suggested (Prescott, 1931) that these wind-blown sandhill accumulations are principally the result of denudation from these limestone areas and are associated with the low rainfall per wet day characteristic of the head of the Great Australian Bight, and of the areas immediately to the east of the Murray at Tailem Bend. In addition to mallee, the characteristic vegetation of these sandhills includes porcupine grass *(Triodia irritans)*. Only the eastern area, however, comes within the zone of economic development.

The Murray Mallee soils, at least within the great bend of the Murray, are principally derived from fluviatile and lacustrine beds which overlie the marine tertiary deposits with western limits approximately as indicated in fig. 1. Subsequent to their deposition an arid cycle appears to have supervened, resulting in a resorting of the material into a series of sandhills and shallow valleys or "flats." The resulting topography makes for a considerable variation in soil type through the area, so that on every farm many types are represented but with much repeti-

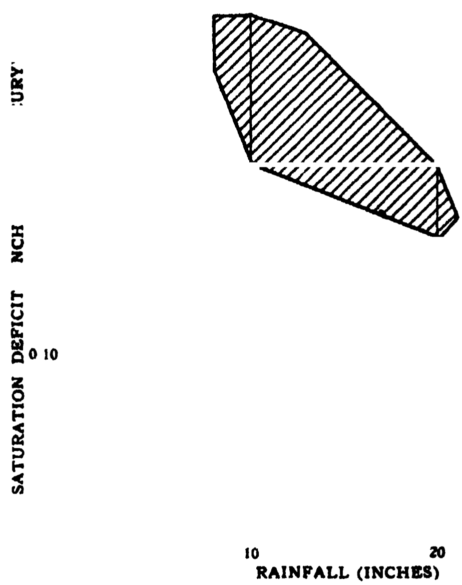

Fig. 2.

Showing the climatic limits of mallee soils in South Australia.

tion of the pattern from farm to farm. What appear to be remnants of swamps in the lacustrine period occur in the form of ironstone concretions varying from relatively massive structures to ironstone gravels, particularly to the east of a line drawn south from Alawoona. These occurrences are very occasional, they are scattered and their distribution is not particularly well known.

Climatic Considerations.

In the consideration of the climatic control of soil type, four major factors have been shown to have a bearing on the distribution of the mallee soils: The mean annual rainfall, the control of its efficiency by evaporation, the seasonal character of the rainfall, and the daily incidence of the rainfall. The first two controls are treated graphically in fig. 2, where the climatic limits of the mallee soils as imposed by rainfall and atmospheric saturation deficit are considered.

The rainfall varies from 8 inches per annum to 21 inches, with saturation deficits ranging from 0·28 inches to 0·16 inches.

The seasonal incidence of the rainfall is one of winter maximum with from 60 per cent. to over 70 per cent. falling in the months April to September.

The rainfall per wet day is in general below 0·20 inches in the most characteristic areas, but falls to 0·14 inches at Fowler's Bay and Cooke's Plains. This latter station is associated with an appreciable area with 0·15 inches or less.

These low rainfalls per wet day make for high rainfall penetration but for little leaching and no run-off, with the result that the mallee areas fall into a

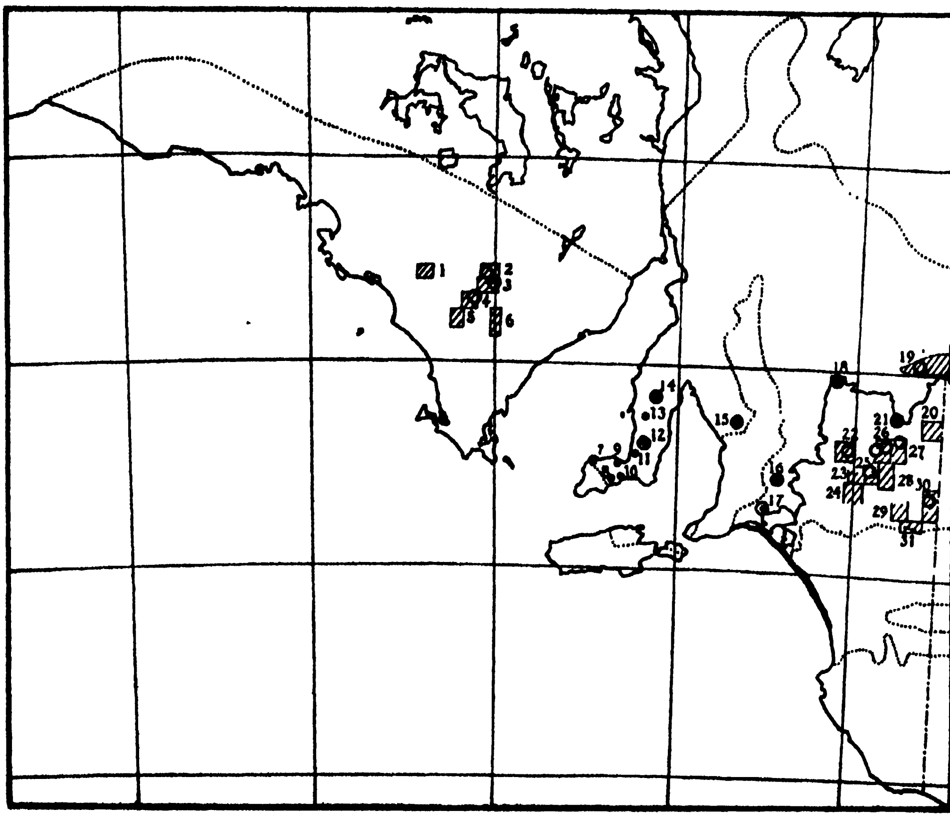

Fig. 3.

Map of portion of South Australia, showing areas from which soil samples have been examined. The circles represent localities from which type profiles have been described.

1. Hd. of Pordia.
2. Hd. of Koongawa.
3. Hd. of Cootra.
4. Hd. of Ulyerra.
5. Hd. of Barwell.
6. Hds. of Murlong & Boonerdo.
7. Corney Point.
8. Hd. of Coonarie.
9. Point Turton.
10. Hd. of Coonarie.
11. Brentwood.
12. Minlaton.
13. Maitland (8 miles south).
14. Maitland (6 miles north).
15. Roseworthy Agricult. College.
16. Monarto.
17. Milang.
18. Hd. of Cadell.
19. County Hamley.
20. Hd. of Bookpurnong.
21. Pyap West.
22. Hd. of Bandon.
23. Hd. of Wilson.
24. Hd. of Marmon Jabuk.
25. Hd. of McPherson.
26. Hd. of Mindarie.
27. Hd. of Allen.
28. Hd. of Auld.
29. Hd. of Bews.
30. Hd. of Pinnaroo.
31. Hd. of Day.

very typical "Areic" region. This absence of leaching results in appreciable quantities of salt being found in the soils, the accession of cyclic salt being more than sufficient to maintain a balance in the soil. Owing to the relative absence of very heavy soils this salt concentration in the soil is of relatively small economic

importance except under irrigation, when naturally occurring subsoil accumulations of salt may be revealed and may cause serious difficulties.

The Characteristics of the Mallee Soils.

Apart from the recent surveys of the Division of Soil Research, the only important previous descriptions of mallee soils were those of Howell (1911), who dealt with the mechanical and chemical analyses of selected soils from the Victorian mallee. An interpolation of his results show that these soils fall within the same texture groups as the soils more recently examined both in Victoria and New South Wales. In spite of the fact that these soils occur in a relatively arid area, the occurrence of subsoils definitely heavier than the surface soils calls for some explanation. The mobility of the clay, in spite of the presence of much calcium carbonate, may be traced to a degree of saturation of the exchangeable base complex of the soil by sodium, so that these soils may be said to be weakly "solonized." It is also probable, as will be seen later, that much calcium carbonate may actually be present in the finest fractions of the soil, including the clay fraction.

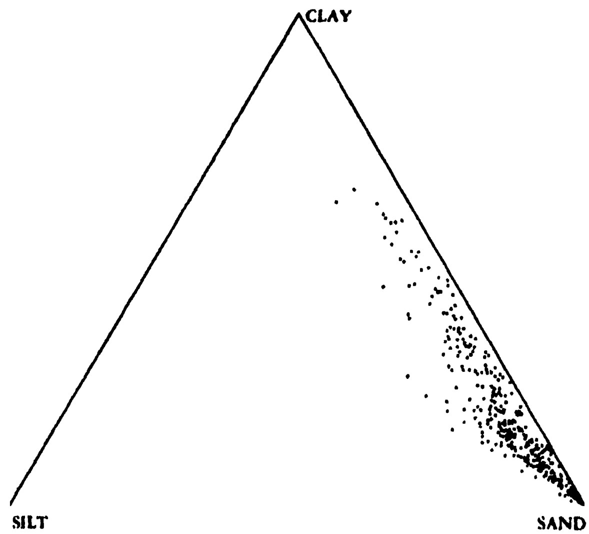

Fig. 4.
Distribution triangle, illustrating mechanical analysis of all samples examined, excluding those from Yorke Peninsula.

The soils vary in colour from reddish brown to a light fawn or cocoa colour, this latter being very common. The range of types varies with the amount of calcium carbonate present; in most instances this is present in the form of a limestone rubble, but occasionally a cementation occurs where calcium carbonate occurs in heavy amounts so as to form sheet limestone or travertine horizons. At the other extreme of the scale come the light-coloured sands of the sandhill formations, which tend to drift under cultivation after a succession of dry seasons.

The Collection of Typical Samples.

During the past eight years a number of soil samples have been collected from various localities in the mallee areas, partly through the interest of Mr. E. S. Alcock in the problems of the Murray Mallee and through the courtesy of officers of the Lands Department engaged in the classification and subdivision of land in Eyre Peninsula and north of the Murray. In addition a number of type profiles

have been collected, and in presenting the data due weight has been given to geographical distribution so as to give a representative picture over as wide a range as possible.

In all, 328 samples have been examined from 148 localities. In fig. 3 a key map is given showing the locality distribution of the soil samples.

All samples have been examined for mechanical analysis and nitrogen content, while 19 complete profiles have been examined for the most important characteristic data.

Mechanical Analysis.

With the exception of the samples from Yorke Peninsula, all the samples fall into a highly characteristic grouping with respect to the mechanical composition of the mineral fraction free from calcium carbonate. The main characteristic is a low silt content, rarely more than 10 per cent, and a clay content varying in the complete range of surface and subsoil samples from 2 per cent. to 64 per cent. The geographical distribution of texture in surface and subsoils is given in Table 1, while the complete range of distribution is depicted graphically in fig. 4.

Table 1.

Frequency Distribution of Clay Percentage in Mallee Soils and Subsoils.

	SURFACE SOILS.									SUSOILS.										
% Clay.	0 to 5	5 10	10 15	15 20	20 25	25 30	30 35	35 40	40 45	0 to 5	5 10	10 15	15 20	20 25	25 30	30 35	35 40	40 45	45 50	over 50
County Musgrave—																				
Hd. Ulyerra	2	7	5	1							3	5	1							
Hd. Barwell	2		3	2	1							1								
County Jervois—																				
Hd. Boonerdo	2	2	2	2						1	1	1	2							
Hd. Murlong	1		1									1								
County LeHunte—																				
Hd. Pordia	1		1		1					1			1		1					
Hd. Cootra		1	2									1	4	2						
Hd. Koongawa	1	1									1	2	3							
County Fergusson	1		1	1	2		2		1					2		2			1	2
County Albert—																				
Hd. Bandon	4	2								4	4	1	1							
Hd. Mindarie	2		2	1						2	1	1	2		3	1				
Hd. Cadell		1														1		1		
County Alfred—																				
Hd. Allen	2		4							3	1	3	1		3	1				
Hd. Bookpurnong		1	3									3	4	1	1					
Hd. Pyap		1									2	3								
County Buccleugh—																				
Hd. Wilson		2										4								
Hd. McPherson		4									1	3								
Hd. Marmon Jabuk	1	1	2	1	1													1	2	1
County Chandos—																				
Hd. Pinnaroo	1	3	1	4	4	4	2	1		1			1	9	13	5		2		
Hd. Bews	1						1	1				1						1		
Hd. Auld	4		3		1					4		5		1	2	2		1		
Hd. Day	6	1	1		1															
County Hamley	2	3	8		1					1	4	8	6		1					1
Miscellaneous	1	4		1		2	2					1			3	2	1	1	2	2
Totals	34	34	39	13	12	6	7	2	1	17	18	44	26	15	27	14	1	7	5	6

In fig. 5 the mechanical analyses of the samples from the selected profiles are given on the distribution triangles. It will be seen that the texture of these soils places them definitely into a restricted range of classes with sands and sandy loams in the surface soils and subsoils, extending to sandy clay loams, sandy clays, and clays for the subsoils.

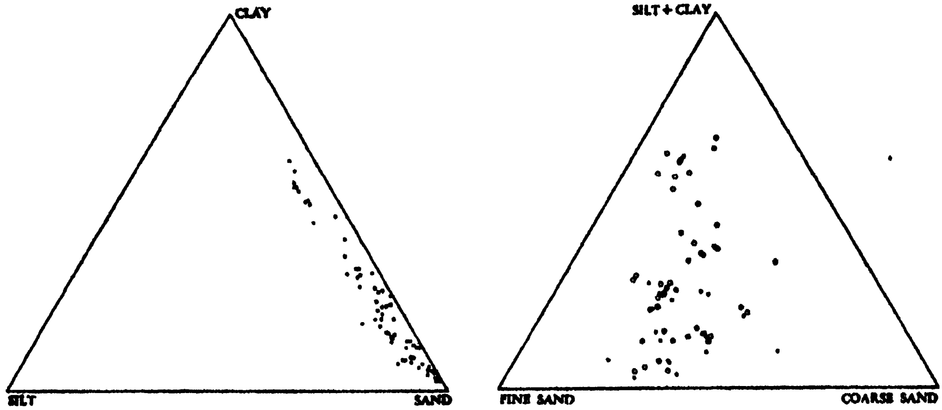

Fig. 5.

Distribution triangles, illustrating the mechanical analyses of the samples from selected profiles, excluding Nos. 2,460-61. Black circles represent surface soils, open circles represent subsoils.

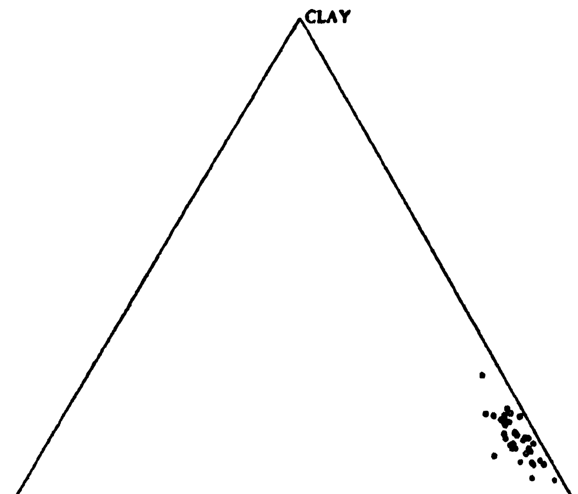

Fig. 6.

Distribution triangle, illustrating the mechanical analyses of the Murray sand. Black circles represent surface soils, open circles represent subsoils.

One of the types commonly found along the River Murray is the Murray sand, which was originally described by Taylor and England (1929) as Type 1 of the irrigated soils of the Murray Valley. The distribution triangle for a number of examples of this type from Coomealla and Goodnight (New South Wales), Woorinen (Victoria) and Renmark (South Australia) is illustrated in fig. 6. The samples secured from Yorke Peninsula show, with one or two exceptions at the northern end, a departure from the general distribution, there being much more

silt present, especially in the surface soils. The distribution triangle for these soils is given in fig. 7.

The mechanical analyses of the samples from the type profiles have also been plotted within a tetrahedron, a stereoscopic pair of representations of which are illustrated in pl. VI. The characteristic distribution of the samples about a plane within the tetrahedron is to be noted.

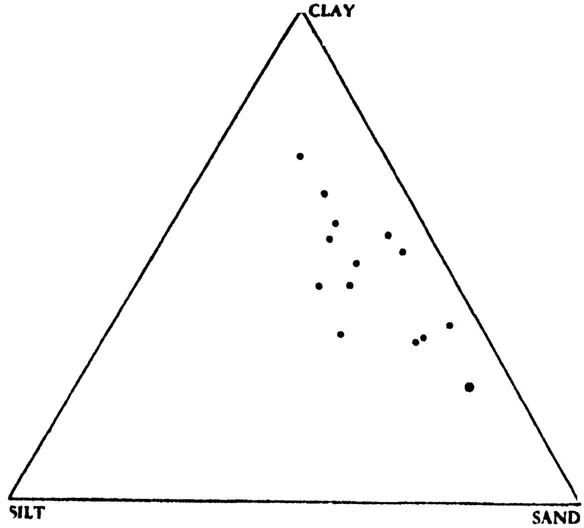

Fig 7.

Distribution triangle, illustrating the mechanical analyses of mallee soils from Yorke Peninsula. Black circles represent surface soils, open circles represent subsoils.

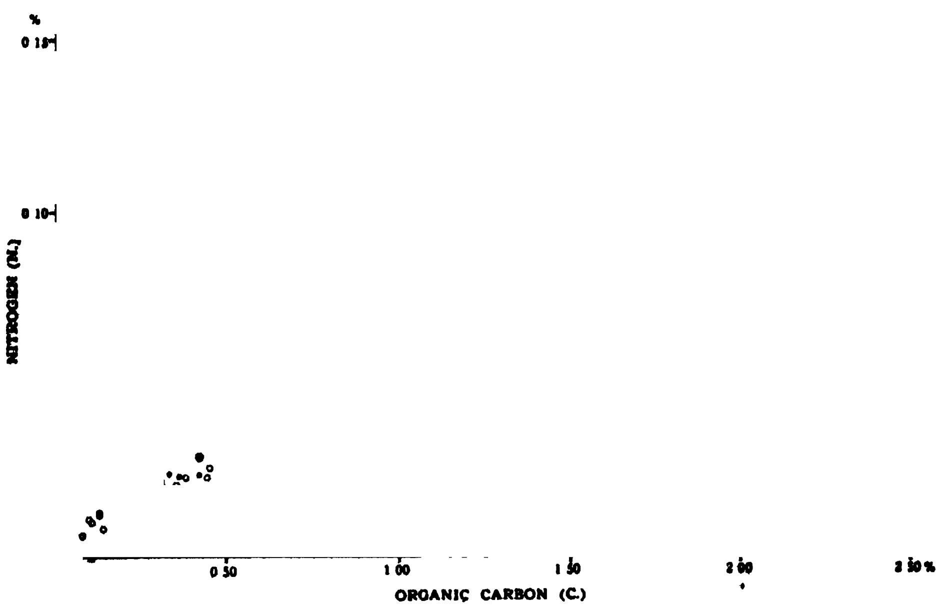

Fig. 8.

Illustrating the relationship between the nitrogen and organic carbon contents of typical mallee soils. Black circles indicate surface soils, open circles indicate subsoils.

TABLE 2.

Frequency Distribution of Calcium Carbonate Percentage in Mallee Soils and Subsoils.

SURFACE SOILS.

Clay %	0 to 3	3 to 6	6 to 9	9 to 12	12 to 15	15 to 18	18 to 21	21 to 24	24 to 27	27 to 30	30 to 33	33 to 36	36 to 39	39 to 42	42 to 45	45 to 48	48 to 51	over 51
0—5	27											1					1	2
5—10	25	3	1		1	1						2	1				1	
10—15	28	2	4	1	3						1							1
15—20	11		1													1		
20—25	5	3	1	1				1	1									
25—30	4		2															
30—35	3	1	1	1	1	1												
Over 35		1	1		1													
	103	10	11	3	6	2		1	1		1	3	1			1	2	3
County Musgrave	9		1	1	1	1					1	3	1				1	1
„ Jervois	7				1												1	
„ LeHunte ..	8																	
„ Fergusson	2	1	1					1								1		2
„ Albert	11	1																
„ Alfred	9		2															
„ Buccleugh	7	3	1															
„ Chandos ..	27	5	3	1	1	1			1									
„ Hamley	8		3		2													
Murray Sands	6																	
Miscellaneous	9			1	1													
	103	10	11	3	6	2		1	1		1	3	1			1	2	3

SUBSOILS

Clay %	0 to 3	3 to 6	6 to 9	9 to 12	12 to 15	15 to 18	18 to 21	21 to 24	24 to 27	27 to 30	30 to 33	33 to 36	36 to 39	39 to 42	42 to 45	45 to 48	48 to 51	over 51
0—5	17																1	1
5—10	13	2	1			2	1		1				1				1	
10—15	15	7	7	3	2	3	5		1	1	1	1		1				
15—20	5	6	3	3	5	3	1	2	2	2	2	1						
20—25	2		3	3	1	4	1	2	1	1								
25—30	3	1	4	3	6	3		2		2		1						
30—35			2	2	2	3	1	2	2	2					1			
Over 35	4	2	6	2	2		1											
	59	18	26	16	18	18	10	8	7	8	3	3	1	1	1		2	1
County Musgrave	2	1	2	1		2								1			1	
„ Jervois	3	2					1										1	
„ LeHunte ..	4	1	3		2		2	1	1			1	1					
„ Fergusson	1	1	1	1						2					1			1
„ Albert	10	2	3	3	2			1	1	1								
„ Alfred	8	3	3		2	3	1			3	3							
„ Buccleugh		1	2	2	1	1	1			1		1						
„ Chandos ..	11	1	9	3	7	10	2	3	1	1								
„ Hamley	8	2		1	3	2	2	2	2									
Murray Sands	5	4	2	5	1				1									
Miscellaneous	7		1				1	1	1			1						
	59	18	26	16	18	18	10	8	7	8	3	3	1	1	1		2	1

TABLE 3.

Comparison of Mechanical Analyses carried out by Two Methods with and without the Removal of Calcium Carbonate.

Locality. Hd. Pinnaroo. Sect. 80.

Soil No.	1892		1893		1894		1895		1896	
Depth	0—8"		10—18"		18—24"		24—30"		30—36"	
	a %	*b* %	*a* %	*b* %	*a* %	*b* %	*a* %	*b* %	*a* %	*b* %
Coarse Sand	30·9	—	18·9	18·9	21·0	21·5	24·0	25·[illegible]	28·6	28·8
Fine Sand	37·9	—	27·5	31·5	26·5	29·1	29·3	29·[illegible]	28·3	28·8
Silt	6·6	—	4·2	13·4	4·0	9·6	3·8	6·1	3·6	4·7
Clay	17·9	—	19·7	30·7	22·3	35·6	25·7	34·6	29·6	33·0
Loss on Acid Treatment	2·0	—	26·7	—	23·3	—	13·4	—	6·5	—
Moisture	3·6	—	4·0	3·8	4·9	4·9	4·8	4·[illegible]	5·1	5·1
	98·9	—	101·0	98·3	102·0	100·7	101·0	101·[illegible]		
Calcium Carbonate	0·59		24·8		21·5		12·6		5·2	
Loss on Ignition of Clay Fraction	15·6·	—	14·2	27·0	15·2	26·1	12·9	21·[illegible]	12·0	15·7
Percentage of total $CaCO_3$ present in Clay Fraction	—		47		63		70		73	

Locality. Hd. Mudla Wirra (Roseworthy Agric. College).

Soil No.	2369		2370		2371		2372		2373	
Depth	0—6"		6—12"		12—20"		20—24"		24—30"	
	a %	*b* %	*a* %	*b* %	*a* %	*b* %	*a* %	*b* %	*a* %	*b* %
Coarse Sand	18·7	18·2	10·8	11·1	9·7	9·3	9·2	8·5	9·9	8·5
Fine Sand	47·5	50·6	26·3	26·5	23·6	25·0	23·5	25·1	24·0	26·8
Silt	9·3	11·7	6·6	5·9	4·3	10·1	5·0	10·3	5·9	9·8
Clay	16·8	15·4	49·4	50·7	47·0	52·9	37·4	54·5	32·3	52·7
Loss on Acid Treatment	2·7	—	2·0	—	9·5	—	21·4	—	25·2	—
Moisture	1·9	1·9	5·9	5·9	5·5	5·4	4·2	4·1	3·7	3·7
	96·9	97·8	101·0	100·1	99·6	102·7	100·7	102·5	101·0	101·5
Calcium Carbonate	1·13		0·26		8·6		19·8		23·3	
Loss on Ignition of Clay Fraction	17·6	15·0	14·6	10·5	13·6	15·0	15·0	23·7	14·9	26·1
Percentage of total $CaCO_3$ present in Clay Fraction	—		—		50		81		85	

(a) Analysis by International Method—in which $CaCO_3$ is removed by preliminary acid treatment.

(b) Analysis by modification of Troell's hypobromite pre-treatment—no removal of $CaCO_3$.

Chemical Characteristics.

Calcium Carbonate.

The calcium carbonate content of the mallee soils shows a wide range, and the distribution table illustrating this range is given in Table 2.

Neither in relation to mechanical analysis nor in relation to geographical occurrence is there any marked systematic distribution or correlation. In the case of two soil profiles from Pinnaroo and Roseworthy, respectively, the mechanical analysis on the samples was carried out without acid pretreatment, using a modification of Troell's hypobromite method (1931) which does not entail the removal

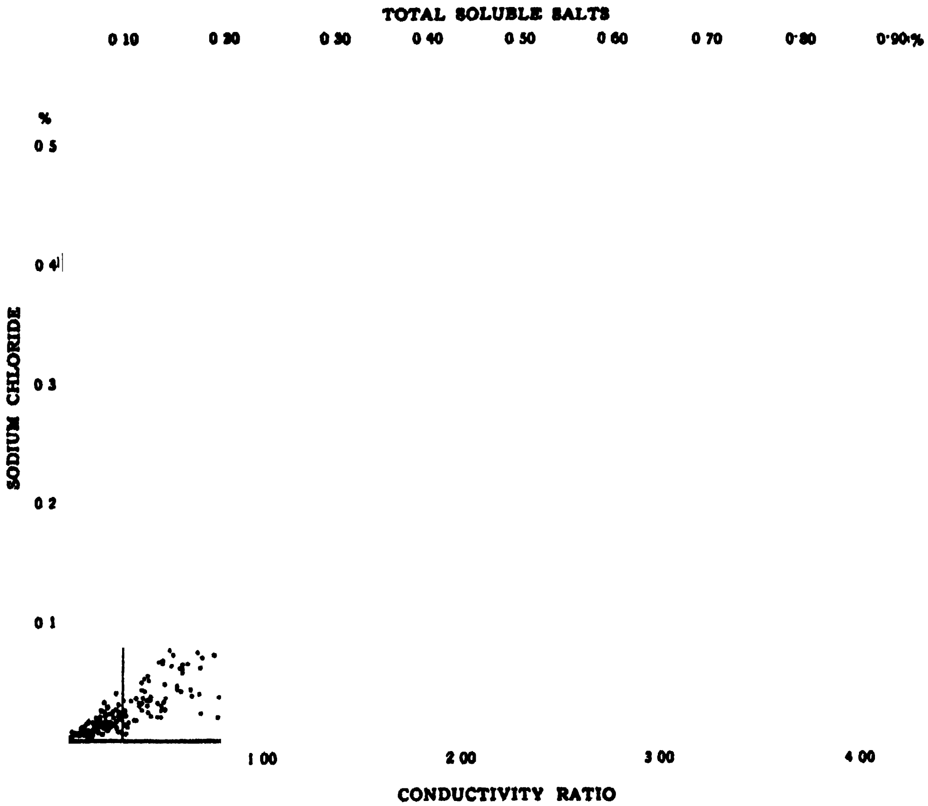

Fig. 9.
Correlation between sodium chloride content of mallee soils conductivity ratio and total soluble salt content.

of calcium carbonate. These analyses (Table 3) revealed the fact that much of the calcium carbonate in these soils is in an extremely fine state of division, including a high proportion of particles within the clay fraction.

It is evident that where a detailed knowledge of the physical texture of these calcareous soils is required, as in irrigation problems for example, the mechanical analysis should be carried out by two methods, one involving preliminary acid treatment and the second permitting of the dispersion of the calcium carbonate. In spite of this high proportion of calcium carbonate, the relative proportion of replaceable sodium in the soils is high and appears to contribute to the ease of

dispersion of this calcium carbonate. How far a certain proportion of the calcium carbonate is replaced by magnesium carbonate has so far not been investigated.

Reaction—Hydrogen Ion Concentration.

As was indicated in a previous paper (Prescott, 1927), these soils are mostly alkaline, as would naturally be expected from the high carbonate content and from the study of the replaceable bases. A number of surface and subsurface sands may on occasion be as acid as pH 6, but on the whole there is a tendency for a maximum frequency of occurrence between pH 8, and pH 9, with subsoils frequently more alkaline than this. The true values are probably somewhat higher than indicated for the higher values as the quinhydrone electrode was used in their electrometric determination, no other routine electrode method having as yet been standardised for this group of soils.

The frequency distribution of these soils with respect to hydrogen ion concentration is given in Table 4.

TABLE 4.

Frequency Distribution of the Reaction of Mallee Soils and Subsoils.
(Quinhydrone electrode.)

pH.	5·8 to 5·9	5·9 to 6·0	6·0 to 6·1	6·1 to 6·2	6·2 to 6·3	6·3 to 6·4	6·4 to 6·5	6·5 to 6·6	6·6 to 6·7	6·7 to 6·8	6·8 to 6·9	6·9 to 7·0	7·0 to 7·1	7·1 to 7·2	7·2 to 7·3	7·3 to 7·4	7·4 to 7·5
Surface Soils	1	1				1	1	2		3	1	3	5	2	6	4	4
Subsoils									1	1	1	2	5				1

pH.	7·5 to 7·6	7·6 to 7·7	7·7 to 7·8	7·8 to 7·9	7·9 to 8·0	8·0 to 8·1	8·1 to 8·2	8·2 to 8·3	8·3 to 8·4	8·4 to 8·5	8·5 to 8·6	8·6 to 8·7	8·7 to 8·8	8·8 to 8·9	8·9 to 9·0	9·0 to 9·1	9·1 to 9·2	9·2 to 9·3	9·3 to 9·4
Surface Soils	3	4	3	9	5	13	8	18	10	9	11	5	5	4	3	3			
Subsoils	4	3	3	2	4	3	8	7	11	16	17	15	18	22	16	13	7	5	2

Nitrogen and Organic Matter.

In few of the mallee soils is there any obvious sign of humus, most of the surface soils containing less than 0·10% of nitrogen and the subsoils less than 0·05%. A few values occur above these limits but are rather scattered, as will be seen on reference to Table 5. There is a definite correlation between texture and nitrogen content, the heaviest soils being also the highest in organic matter.

In a number of representative cases organic carbon was also determined, and a rather wide carbon nitrogen ratio of about 15 to 1 obtained as a general mean, but tending to an obviously definite limit of 10 to 1. This relationship is illustrated graphically in fig. 8. In these mallee soils, many of them virgin or within a few years of their virgin condition, organic matter includes a certain amount of charcoal from the clearing burns, some visibly undecomposed woody material, and very occasionally unquestioned traces of essential oils which usually have the characteristic odour of sandalwood. Of the samples examined, No. 2,138 was the most remarkable in this respect. Soil samples are occasionally received from

TABLE 5.

Frequency Distribution of Nitrogen Percentage in Mallee Soils and Subsoils.

SURFACE SOILS.

Clay %	0 to .01	.01 to .02	.02 to .03	.03 to .04	.04 to .05	.05 to .06	.06 to .07	.07 to .08	.08 to .09	.09 to .10	.10 to .11	.11 to .12	.12 to .13	.13 to .14	.14 to .15	.15 to .16	.16 to .17	.17 to .18	.18 to .19	.19 to .20	.20 to .21	.21 to .22	.22 to .23	.23 to .24	.24 to .25	.25 to .26
0—5	2	11	9	3	1	2		1								1								1		
5—10		2	8	6	3	5	4	1	2			1	1				1	1								
10—15		1	6	6	7	4	2	5	3	3	2				1				1					1		
15—20				2	2	2	3	1	1		1			1				1						1		
20—25					1	3	3	1	1			2														1
25—30				1	2			1	2																	
30—35					2		1	1	1	1	1															
Over 35					1		1											1								
	2	14	23	18	19	16	14	11	10	4	4	3	1	1	1	1	1	3	1					3		1
County Musgave		3	2	1	1	2	1	2	1	1	3	1			1		1	1								
„ Jervois		2	1					1	1	1			1			1		1								
„ LeHunte		1		3		1	1			1									1							
„ Fergusson							1			1		1						1						3		1
„ Albert		2	2	1	2	1	2		2																	
„ Alfred		1	4	2	2	1		1																		
„ Buccleugh					2	5	2	3																		
„ Chandos	1	4	5	5	6	5	6	2	5			1														
„ Hamley	1		4	2	4	1	1	1																		
Miscellaneous		1	5	4	2			1	1		1			1												
	2	14	23	18	19	16	14	11	10	4	4	3	1	1	1	1	1	3	1					3		1

SUBSOILS.

Clay %	0 to .01	.01 to .02	.02 to .03	.03 to .04	.04 to .05	.05 to .06	.06 to .07	.07 to .08	.08 to .09	.09 to .10	.10 to .11	.11 to .12	.12 to .13	.13 to .14	.14 to .15	.15 to .16	.16 to .17	.17 to .18	.18 to .19	over .19
0–5	8	7	1																	
5–10	1	6	2	3			2						1	1		1				
10–15	1	5	4	7	4	4	2	1			1	2								
15–20	1	4	4	7	2					1	1		1							
20–25		1	3	4	1						1									1
25–30		3	7	8																
30–35		2	2	3	3		1													
Over 35			4	7	2		3													
	11	28	27	39	12	4	8	1		1	3	2	2	1		1				1
County Musgrave		2		1			2				2	2								
„ Jervois			1		2					1			1	1						
„ LeHunte	1	4	2	1	1	1							1							
„ Fergusson			1	1			2				1					1				1
„ Albert	2	8	2	3			1													
„ Alfred	3	7	5	5																
„ Buccleugh				4		2														
„ Chandos	4	5	9	14	5	1	1	1												
„ Hamley	1	2	4	7	2															
Miscellaneous			3	3	2		2													
	11	28	27	39	12	4	8	1		1	3	2	2	1		1				1

TABLE 6.

Frequency Distribution of Chlorides (expressed as per cent. Chlorine) in Mallee Soils and Subsoils.

SURFACE SOILS (to 9-12").

Clay %	0 to ·01	·01 to ·02	·02 to ·03	·03 to ·04	·04 to ·05	·05 to ·06	·06 to ·07	·07 to ·08	·08 to ·09	·09 to ·10	·10 to ·11	·11 to ·12	·12 to ·13	·13 to ·14	·14 to ·15	·15 to ·16	·16 to ·17	·17 to ·18	Over ·18
0–5	31	1										1							
5–10	25	3	4				1			1									1
10–15	31	6	1	2	1	2	1	2											
15–20	2	3	3	1	1		1												1
20–25	4	5	1	1															
25–30		3	1		1			1											1
30–35	1	1	2	1								1							
Over 35		1			2														
	94	23	12	5	5	2	3	3		1		2							3

	0 to ·01	·01 to ·02	·02 to ·03	·03 to ·04	·04 to ·05	·05 to ·06	·06 to ·07	·07 to ·08	·08 to ·09	·09 to ·10	·10 to ·11	·11 to ·12	·12 to ·13	·13 to ·14	·14 to ·15	·15 to ·16	·16 to ·17	·17 to ·18	Over ·18
County Musgrave ...	11	1	1	1	2		2			1		1							1
„ Jervois	8	1																	
„ LeHunte	6	1	1																
„ Fergusson		5	1	1															1
„ Albert	10	2																	
„ Alfred .	8	1		1		1													
„ Buccleugh ...	5	4	3			1		1											
„ Chandos	23	5	6		3			1				1							
„ Hamley ...	13	1																	
Murray Sands	3						1	1											1
Miscellaneous	7	2		2															
	94	23	12	5	5	2	3	3		1		2							3

SUBSOILS (to approx. 30")

Clay %	0 to ·01	·01 to ·02	·02 to ·03	·03 to ·04	·04 to ·05	·05 to ·06	·06 to ·07	·07 to ·08	·08 to ·09	·09 to ·10	·10 to ·11	·11 to ·12	·12 to ·13	·13 to ·14	·14 to ·15	·15 to ·16	·16 to ·17	·17 to ·18	Over ·18
0–5	15	2	1																
5–10	12	1	2				2												
10–15	16	7	4		3	2	1	1	2	2	1	1					1		2
15–20	7	6	2	2	2	2				1	1	1				1			2
20–25	1	7				2		2			2	1		1					
25–30 ...	2	5	2	1	2	1	3		3			1		3		2			
30–35		1	1		1	1	2	2	2		1				1	1			
Over 35 .	1	1	1	2		2		1		1		2	1					1	2
	54	30	13	5	8	10	8	6	7	4	5	6	1	4	1	4	1	1	6

	0 to ·01	·01 to ·02	·02 to ·03	·03 to ·04	·04 to ·05	·05 to ·06	·06 to ·07	·07 to ·08	·08 to ·09	·09 to ·10	·10 to ·11	·11 to ·12	·12 to ·13	·13 to ·14	·14 to ·15	·15 to ·16	·16 to ·17	·17 to ·18	Over ·18
County Musgrave ..	4	3					1										1		
„ Jervois	3	2		2															
„ LeHunte	2	1	1		2	1						2		1					3
„ Fergusson		1	2	1		1		1	1										
„ Albert ..	10	1	2		1		1		1	1		1				2			
„ Alfred	10	3	1		2	1	1	1	3	1						1			
„ Buccleugh ...		3	1	1		3				1		1							
„ Chandos	9	10	3	1	3	2	3	4	2	1	3			3	1	1			
„ Hamley	11	3	3			1	1				1	1							
Murray Sands	2	1				1					1								1
Miscellaneous	3	2					1					1	1					1	2
	54	30	13	5	8	10	8	6	7	4	5	6	1	4	1	4	1	1	6

mallee areas which refuse to wet under rain and in which seeds do not germinate. On one or two occasions this effect has also been traced to the presence of an essential oil.

This occurrence recalls the work of Greig-Smith (1910, 1911) on waxy or fatty substances in soil, collectively called by him "agricere," and may account in part for a general impression that exists that certain Australian soils contain eucalyptus oils in definite traces.

Soluble Salts.

Although the mallee soils of South Australia contain definite amounts of soluble salts, in relatively few cases is sufficient present to cause anxiety on the part of farmers, and it is principally in the irrigation areas that the special conditions of irrigation practice and local topography unite to cause serious economic

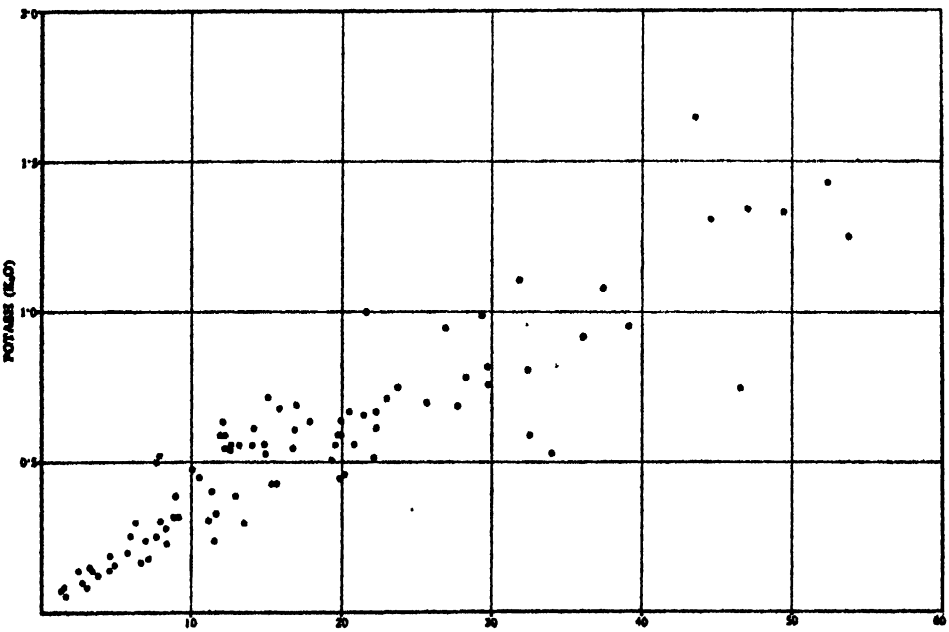

Fig. 10.

Correlation between the acid soluble potassium and clay content of mallee soils.

trouble. The distribution of the chlorides expressed as chlorine in relation to the clay content and locality is given in Table 6, while the relationship between the sodium chloride and total soluble salts is illustrated graphically in fig. 9. There appears to be a relatively wide range of salt content, but a limiting proportion of sodium chloride to total salts will be observed in the neighbourhood of 70 per cent. The mean total salt content to a depth of 24 inches from 78 sites is given as a distribution in Table 7.

TABLE 7.

Frequency Distribution of Total Salt Content in Soils to a Depth of 24 Inches.

Salt, %	0·0 to 0·1	0·1 to 0·2	0·2 to 0·3	0·3 to 0·4	0·4 to 0·5	0·5 to 0·6	0·6 to 0·7	0·7 to 0·8	0·8 to 0·9	0·9 to 1·0
Number of Sites	30	29	16	1	2	—	—	—	—	—

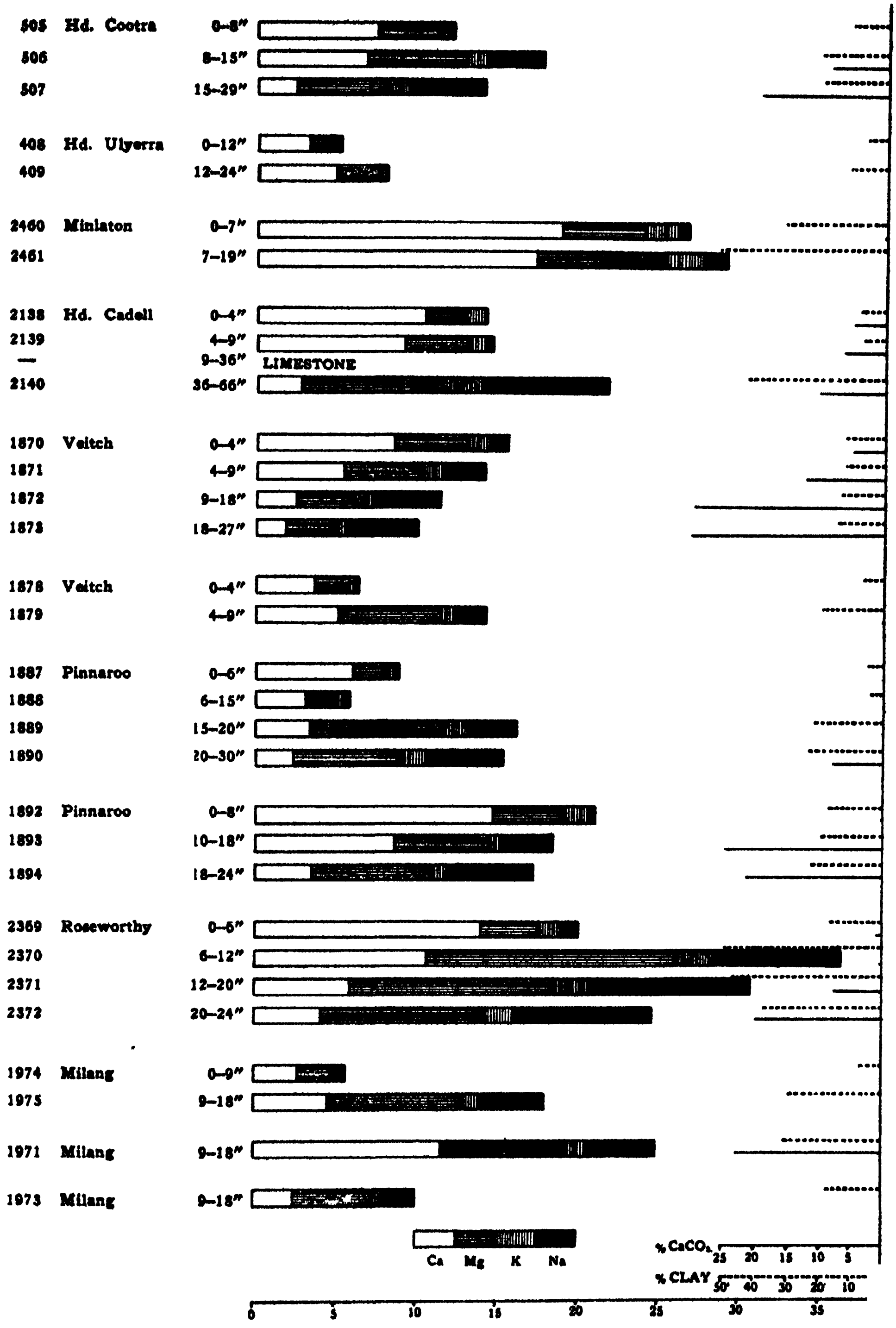

Fig. 11.
Illustrating graphically the exchangeable bases in a number of samples from typical profiles of mallee soils.

Hydrochloric Acid Extracts—Phosphoric Acid and Potash.

A characteristic feature of the mallee soils is their relatively low content of phosphate and the relatively high values for potassium. As is normally the case, this latter value is a function of the clay content of the soil, the ratio of K_2O to clay being approximately 3 per cent. This correlation is illustrated diagrammatically in fig. 10. There is no apparent correlation between the phosphate content and the clay content, and none between the nitrogen content and the phosphate content, except possibly a limiting correlation. Table 8 illustrates the frequency distribution of the potash and phosphoric acid contents of these soils. It is based on the analyses of 91 samples selected to represent as wide a geographical distribution as possible.

TABLE 8.

Frequency Distribution of Acid Soluble Potassium and Phosphoric Acid in Mallee Soils and Subsoils.

Potash (K_2O) %	0 to 0·25	0·25 to 0·50	0·50 to 0·75	0·75 to 1·00	1·00 to 1·25	1·25 to 1·50	1·50 to 1·75
Surface Soils	16	13	21	3	1	1	—
Subsoils	4	5	15	6	2	3	1
Phosphoric Acid (P_2O_5) %	**0 to 0·01**	**0·01 to 0·02**	**0·02 to 0·03**	**0·03 to 0·04**	**0·04 to 0·05**	**0·05 to 0·06**	**0·06 to 0·07**
Surface Soils	8	22	14	7	4	—	—
Subsoils	10	15	9	2	—	—	—

In six cases from the Murray Mallee the hydrochloric acid extracts were examined in further detail, and the data so obtained are recorded below.

TABLE 9.

Analyses of Hydrochloric Acid Extracts of Mallee Soils.

Locality		Pin-naroo	Cope-ville	Hd. Bookpurnong, Sect 87	Hd Mindarie, Sect. 48		Yurgo
Soil No.		276	300	316	322	323	348
Depth		0–9"	0–9"	0–9"	0–9"	9-18"	0–9"
		%	%	%	%	%	%
Ferric Oxide	Fe_2O_3	2·07	0·72	2·53	2·96	3·80	3·46
Alumina	Al_2O_3	5·10	1·29	5·71	6·61	8·66	6·05
Calcium Oxide	CaO	4·84	0·24	0·73	1·14	5·31	0·35
Magnesia	MgO	0·87	0·12	0·58	0·51	1·14	0·47
Potash	K_2O	0·46	0·14	0·72	0·61	0·95	0·51
Manganese Oxide	Mn_3O_4	0·010	0·003	0·020	0·017	0·017	0·008
Titanium Dioxide	TiO_2	0·09	0·06	0·13	0·12	0·14	0·12
Phosphoric Acid	P_2O_5	0·022	0·012	0·028	0·031	0·028	0·020
Clay		20·2	2·6	15·0	16·9	27·0	19·3
Calcium Carbonate		7·11	0·01	0·34	1·21	9·84	0·04

Exchangeable Bases.

Apart from the physical composition of these mallee soils, the most important characteristic lies in the relative proportions of their replaceable bases. In all cases a relatively high proportion of magnesium to calcium is to be observed, and in most cases a marked degree of sodium saturation in the subsurface and subsoil horizons. As a result of this, the clays of the subsoils usually peptise readily in spite of the presence of calcium carbonate, and under irrigation are frequently relatively impervious to water. Under natural conditions the main effect is the formation of illuvial horizons of heavier texture than the surface soil, a process which one may regard as a mild degree of "solonization."

Fig. 11 summarises graphically a number of examples of exchangeable base determinations.

NOTES ON THE ANALYTICAL METHODS EMPLOYED.

In general, the analytical methods used were those outlined elsewhere (Prescott and Piper 1928, and Piper and Poole 1929). The fractions separated in the mechanical analysis were those adopted internationally. In addition to the standard mechanical analysis, two calcareous profiles were analysed by a slight modification of Troell's hypobromite method (Troell, 1931).

Organic carbon was determined gravimetrically by the usual dry combustion method. When carbonates were present in the soil they were removed by a preliminary treatment with sulphurous acid.

Total soluble salts were determined by a conductimetric method, the conductivity (*i.e.*, the ratio of the resistance of a ·005 N. solution of potassium chloride to the resistance of the 1:5 soil suspension) being measured. The method was standardised by determining the relationship between this conductivity ratio and total salts (determined by the conventional filtration method) on a number of the soils. From the graph so constructed the approximate amount of "total soluble salts" corresponding to each value of the conductivity ratio was ascertained. Chlorides were also determined in all samples, an electrometric titration method being used (Best, 1929).

Owing to some uncertainty of the values obtained with the antimony electrode for these soils, the reaction has been determined throughout by the quinhydrone electrode, a 1:1 soil water suspension being used.

Exchangeable potassium and sodium were determined by leaching the soil with a normal solution of recrystallized ammonium chloride, potassium being determined as perchlorate, and sodium as sodium uranyl magnesium acetate. Soluble salts were removed from the soil by a preliminary leaching with 40% alcohol before determining the exchangeable bases. Exchangeable calcium and magnesium were also determined in the ammonium chloride extracts of soils containing less than 0·2 to 0·25% calcium carbonate, a suitable correction being applied for the dissolved carbonate. Where more than this amount of calcium carbonate was present in the soil, exchangeable calcium and magnesium were determined in sodium chloride extracts according to a slight modification of Hissink's method (Hissink, 1923). These bases were also determined in some of the calcareous soils by leaching with N/5 potassium chloride in 63% alcohol (Chapman and Kelley, 1930), and by N/1 sodium chloride (cold digestion). Both the latter methods gave results comparable with those obtained by Hissink's method.

RECORDS OF TYPICAL PROFILES OF MALLEE SOILS.

For permanent reference, in view of the fact that little work has previously been recorded for these soils, nineteen profiles have been examined in some detail, and the data are recorded in an appendix to this paper.

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EXPLANATION OF PLATE VI.

Stereoscopic pair of diagrams, illustrating the plotting within a tetrahedron of mechanical analyses of samples from type profiles of mallee soils. Clay is represented by the upper angle, silt by the left-hand angle, coarse sand by the far angle, and fine sand by the angle on the right. The distribution of the plotted points about a plane is to be noted. Black circles represent surface soils, open circles represent subsoils.

Appendix.

Locality and Description of Type Profiles.

Hundred of Cootra. N. boundary. Section 9. Soil Nos. 505-508.
 Sample collected by the Department of Lands and Survey, 1927.
 Native Vegetation as described by the surveyor: Low mallee and wirebush.

Hundred of Koongawa. Sect. 18. Soil Nos. 499-502.
 Sample collected by the Department of Lands and Survey, 1927.

Hundred of Ulyerra. Sect. 43. Soil Nos. 408, 409.
 Sample collected by the Department of Lands and Survey, 1926-27, representing flat area between sand ridges.
 Native vegetation: Thick whipstick mallee and stunted mallee, broom, scrub mulga and porcupine grass.

Hundred of Minlacowie. 0·8 miles along Minlaton-Curramulka road, from Minlaton corner. Soil Nos. 2,460, 2,461.
 Sample collected by C. S. P., Mar. 1930; typical of flat country between gentle rises. 0-7″ red-brown clay loam, passing to heavy red clay 7-19″ and sheet limestone at 19″.
 Native vegetation: Large mallee.

Hundred of Maitland. 6 miles north of Maitland along Maitland-Arthurton road. Soil Nos. 2,465-2,467.
 Sample collected by C. S. P., Mar. 1930; 0-4″ red sandy clay, passing to heavy red clay with calcium carbonate (4-16″) and red clay with calcium carbonate rubble increasing 16-26″.
 Native vegetation: Mallee, broombush, and some small titree.

Hundred of Mudlawirra. No. 2 field Roseworthy Agricultural College. Soil Nos. 2,369-2373.
 Sample collected by C. S. P., Oct., 1931, from area of virgin mallee scrub; grey-brown sandy loam 0-6″, passing to heavy red-brown clay 6-20″. Calcium carbonate appeared at 12″, increasing to heavy lime at 20-30″.

County Hamley (P.L. 693, 10 chains south of Timor dam). Soil Nos. 469-471.
 Sample collected by the Department of Lands and Survey, 1926; brown sandy loam typical of plains, but limestone rubble more pronounced in other parts.
 Native vegetation as described by the surveyor: Sandalwood *(Myoporum)*, herbage and little grass.

Hundred of Pinnaroo. Sect. 109. Soil Nos. 1887-1891.
 Sample collected by J. A. P., Oct., 1930, typical of sandhill formation; grey sand 0-15″ over red-brown fine sandy loam, with calcium carbonate appearing at 20″.
 Native vegetation: Mallee, barley grass and some wild mustard.

Hundred of McPherson (Sandalwood). Soil Nos. 360-362.
 Sample forwarded by the District Instructor of the Department of Agriculture in 1926.

Hundred of Pinnaroo. Sect. 80. Soil Nos. 1,892-1,896.
 Sample collected by J. A. P., Oct., 1930, being typical of small flats between sandy rises; 0-8″ red-brown sandy loam, passing to lighter coloured calcareous loam at 10″ and continuing to 36″.
 Native vegetation: Mallee.

Hundred of Bandon. Copeville. Soil Nos. 300-302.
 Sample forwarded by the District Instructor of the Department of Agriculture in 1926.

Hundred of Allen. Veitch. Soil Nos. 1,870-1,873 and 1,878-1,881.
Samples collected by the Department of Agriculture in 1930 from the unmanured plot and the plot receiving 2 cwts. of superphosphate per acre at the Veitch Experimental Farm.

Hundred of Cadell. Sect. N. (on Morgan Road, 70 chains south of river). Soil Nos. 2,138-2,141.
Sample collected by C. S. I. R. Division of Soils; 0-4" red-brown sand, 4-9" red-brown sand with heavy rubble, followed by solid limestone 9-30" and heavy rubble 30-36". This was underlain by greenish-brown clay 36-85".
Native vegetation: Mallee (*E. dumosa* and *E. oleosa),* with patches of tussock grass.

County Hindmarsh. Milang. Soil Nos. 1,974, 1,975.
Sample forwarded from property of Messrs. A. H. Landseer Ltd.

Hundred of Pyap (1 mile north of Pyap West, on Loxton Road). Soil Nos. 2,350-2,353.
Sample collected by J. A. P., Sept., 1931, Murray sand; 0-24" red-brown sand, passing to red sandy loam 24-44", with small amount of calcium carbonate.
Native vegetation: Mallee and pine.

Hundred of Monarto (6 miles west of Murray Bridge, on main road). Soil Nos. 2,330-2,333.
Sample collected by J. A. P., Sept., 1931; 0-10" brown sand, changing to heavy red clay (12-29") with little calcium carbonate.

Hundred of Mindarie. Sections 48 and 43. Soil Nos. 322-324 and 331-333.
Samples collected by the District Instructor of the Department of Agriculture in 1926.

		Hd Cootra Sect. 9							Hd. Koongawa. Sect. 18.			
Soil No.		505		506		507		508	499	500	501	502
Depth		0–8"		8–15"		15–29"		29"–	0–5"	5–18"	18–31"	31"–
Horizon		A		B		BC		BC	A	B	BC	BC
Reaction	pH	7·9		8·7		8·8		8·7	8·2	8·7	8·6	8·9
		%		%		%		%	%	%	%	%
Calcium Carbonate		0·03		8·81		19·8		21·0	0·01	0·12	14·8	23·1
Mechanical Analysis—												
Coarse Sand		27·3		20·1		12·3		12·3	35·1	29·6	20·9	18·7
Fine Sand		54·9		41·9		40·6		39·9	56·6	52·9	42·3	36·7
Silt		3·6		3·6		1·9		2·2	2·2	1·9	1·9	2·0
Clay		11·2		20·8		19·9		20·7	4·6	13·5	15·8	17·0
Loss on Acid Treatment		1·0		10·7		23·0		23·4	0·2	0·8	17·0	24·8
Moisture		1·6		3·4		2·8		2·8	0·6	1·4	2·0	1·8
Chemical Data—												
Organic Carbon	C	0·84		0·70		0·33		0·28	0·36	0·19	0·29	0·14
Nitrogen	N	0·037		0·045		0·019		0·013	0·017	0·014	0·016	0·008
Phosphoric Acid	P_2O_5	0·009		0 017		0·012		—	0·009	0·010	0·009	—
Potash	K_2O	0·31		0 56		0·59		—	0·14	0·30	0·43	—
Sodium Chloride (from Chlorine)	NaCl	0 026		0 183		0·275		0·308	0·007	0·076	0·495	0·241
Total Soluble Salts		0·07		0·28		0·45		0·53	0·03	0·18	0·71	0·40
Exchangeable Bases—		m e %	x	m e %	x	m e %	x					
Calcium	Ca	7·24	60	6·64	38	2·39	17	—	—	—	—	—
Magnesium	Mg	3·77	31	6·16	35	5·31	38	—	—	—	—	—
Potassium	K	0·70	6	1·28	7	1·55	11	—	—	—	—	—
Sodium	Na	0·32	3	3·53	20	4·75	34	—	—	—	—	—
Total Bases		12·03	100	17·61	100	14·00	100	—	—	—	—	—

x = Percentage Composition of the Bases   m e % = Milligram Equivalents per 100 Grms Soil.

		Hd. Ulyerra. Sect. 43.				Hd Minlacowie. (Minlaton).				Hd. Maitland (6 Miles North of Maitland).		
Soil No.		408		409		2460		2461		2465	2466	2467
Depth		0–12"		12–24"		0–7"		7–19" †		0–4"	4–16"	16–26"
Horizon		A		B		A		B		A	B	BC
Reaction	pH	6·5		7·8		8·5		7·4		8·2	8·2	8·3
		%		%		%		%		%	%	%
Calcium Carbonate		0·03		0·03		0·45		0·07		1·74	5·91	28·1
Mechanical Analysis—												
Coarse Sand		34·4		32·7		14·4		9·1		19·2	10·2	10·1
Fine Sand		56·4		52·5		23·6		16·6		33·9	23·0	18·5
Silt		1·0		1·1		23·9		14·3		5·0	6·2	4·3
Clay		6·7		11·6		31·9		52·3		32·5	46·6	34·0
Loss on Acid Treatment		0·7		0·7		2·2		1·8		3·9	8·2	29·8
Moisture		0·5		1·2		5·1		7·8		5·0	7·7	5·4
Chemical Data—												
Organic Carbon	C	0·43		0·32		1·40		0·77		1·71	0·91	0·45
Nitrogen	N	0·020		0·020		0·092		0·066		0·067	0·036	0·026
Phosphoric Acid	P_2O_5	0·005		0·007		0·034		0·036		0·014	0·014	0·011
Potash	K_2O	0·17		0·24		1·11		1·43		0·59	0·75	0·53
Sodium Chloride (from Chlorine)	NaCl	0·005		0·003		0·021		0·041		0·044	0·063	0·124
Total Soluble Salts		0·03		0·03		0·06		0·09		0·12	0·17	0·22
Exchangeable Bases—		m.e.%	x	m e %	x	m e.%	x	m e.%	x			
Calcium	Ca	3·18	63	4·86	62	18·72	71	17·17	59	—	—	—
Magnesium	Mg	1·51	30	2·57	32	5·12	19	7·88	27	—	—	—
Potassium	K	0·30	6	0·36	5	1·95	7	2·37	8	—	—	—
Sodium	Na	0·04	1	0·11	1	0·86	3	1·67	6	—	—	—
Total Bases		5·03	100	7·90	100	26·65	100	29·09	100	—	—	—

x = Percentage Composition of the Bases.

† = Sheet Limestone at 19" in the Minlaton Profile.

		Hundred of Mudla Wirra (Roseworthy Agric. Coll.).					County Hamley—Pastoral Lease 693.		
Soil No.		2369	2370	2371	2372	2373	469	470	471
Depth		0–6"	6–12"	12–20"	20–24"	24–30"	0–6"	6–12"	12–18"
Horizon		A	B	B	BC	BC	A	B	B
Reaction	pH	8·5	8·3	8·7	8·8	8·8	9·0	9·2	9·3
		%	%	%	%	%	%	%	%
Calcium Carbonate		1·13	0·26	8·6	19·8	23·3	6·44	12·5	20·2
Mechanical Analysis—									
Coarse Sand		18·7	10·8	9·7	9·2	9·9	42·4	40·2	34·9
Fine Sand		47·5	26·3	23·6	23·5	24·0	31·5	28·3	26·0
Silt		9·3	6·6	4·3	5·0	5·9	5·6	4·9	4·7
Clay		16·8	49·4	47·0	37·4	32·3	12·1	12·3	12·3
Loss on Acid Treatment		2·7	2·0	9·5	21·4	25·2	7·0	13·0	19·9
Moisture		1·9	5·9	5·5	4·2	3·7	1·9	2·1	2·1
Chemical Data—									
Organic Carbon	C	2·07	0·87	0·48	0·35	0·22	0·47	0·43	0·43
Nitrogen	N	0·134	0·067	0·047	0·032	0·019	0·041	0·033	0·030
Phosphoric Acid	P_2O_5	0·036	0·030	0·030	0·028	—	0·032	0·030	0·023
Potash	K_2O	0·55	1·33	1·34	1·08	—	0·64	0·59	0·55
Sodium Chloride (from Chlorine)	NaCl	0·056	0·293	0·336	0·317	0·295	0·008	0·015	0·035
Total Soluble Salts		0·13	0·40	0·52	0·52	0·50	0·05	0·08	0·16

Exchangeable Bases—		2369 m.e.%	2369 x	2370 m.e.%	2370 x	2371 m.e.%	2371 x	2372 m.e.%	2372 x	2373	469	470	471
Calcium	Ca	13·92	70	10·51	29	5·83	19	4·14	17	—	—	—	—
Magnesium	Mg	3·50	17	15·45	42	12·34	40	9·98	40	—	—	-	—
Potassium	K	1·36	7	2·42	7	2·33	8	1·86	8	—	—	—	—
Sodium	Na	1·14	6	8·01	22	10·28	33	8·60	35	—	—	—	—
Total Bases		19·92	100	36·39	100	30·78	100	24·58	100	—	—	—	—

x = Percentage Composition of the Bases. m.e.% = Milligram Equivalents per 100 Grms. Soil.

		Hd. Pinnaroo. Sect. 109. Sand Hill Type.									Hd. McPherson (Sandalwood).		
Soil No.		1887		1888		1889		1890		1891	360	361	362
Depth		0–6"		6–15"		15–20"		20–30"		30–40"	0–9"	9–18"	18–27"
Horizon		A		A		B		B		BC	A	B	B
Reaction	pH	8·5		8·6		8·5		8·8		8·8	8·2	8·8	8·9
		%		%		%		%		%	%	%	%
Calcium Carbonate		0·10		0·03		0·22		8·2		10·0	5·36	20·2	27·5
Mechanical Analysis—													
Coarse Sand		21·1		30·1		23·7		22·2		20·7	28·2	19·8	17·7
Fine Sand		69·2		62·6		49·1		40·3		42·7	51·9	42·5	34·9
Silt		1·6		0·7		1·3		1·3		0·1	3·6	3·6	3·9
Clay		5·8		4·9		22·3		23·8		21·5	8·4	11·7	13·4
Loss on Acid Treatment		0·6		0·4		1·2		9·6		12·0	6·2	21·2	29·1
Moisture		1·0		0·8		3·6		4·5		3·9	1·5	1·9	2·1
Chemical Data—													
Organic Carbon	C	0·84		0·35		0·29		0·29		0·22	0·77	0·53	0·59
Nitrogen	N	0·054		0·021		0·023		0·020		0·014	0·052	0·034	0·021
Phosphoric Acid	P_2O_5	0·015		0·006		0·010		0·011		0·009	0·023	0·018	—
Potash	K_2O	0·20		0·16		0·67		0·75		0·76	0·28	0·33	—
Sodium Chloride (from Chlorine)	NaCl	0·008		0·021		0·117		0·170		0·181	0·021	0·097	0·119
Total Soluble Salts		0·04		0·06		0·21		0·31		0·34	0·10	0·23	0·26
Exchangeable Bases—		m.e.%	x	m.e.%	x	m.e.%	x	m.e.%	x				
Calcium	Ca	5·90	68	3·10	53	3·28	20	2·30	15	—	—	—	—
Magnesium	Mg	2·12	24	1·84	32	8·00	50	6·36	42	—	—	—	—
Potassium	K	0·58	7	0·40	7	1·62	10	1·96	13	—	—	—	—
Sodium	Na	0·09	1	0·46	8	3·18	20	4·60	30	—	—	—	—
Total Bases		8·69	100	5·80	100	16·08	100	15·22	100	—	—	—	—

m.e.% = Milligram Equivalents per 100 Grms. Soil. x = Percentage Composition of the Bases.

		Hd. Pinnaroo. Sect. 80. Typical of Small Flats.								Hd. Bandon (Copeville).		
Soil No.		1892		1893		1894		1895	1896	300	301	302
Depth		0–8"		10–18"		18–24"		24–30"	30–36"	0–9"	9–18"	18–27"
Horizon		A		B		BC		BC	BC	A	B	B
Reaction	pH	8·6		8·5		8·7		8·7	8·7	7·1	7·7	8·1
		%		%		%		%	%	%	%	%
Calcium Carbonate		0·59		24·8		21·5		12·6	5·2	0·01	0·02	0·06
Mechanical Analysis—												
Coarse Sand		30·9		18·9		21·0		24·0	28·6	38·0	36·1	32·6
Fine Sand		37·9		27·5		26·5		29·3	28·3	56·5	58·2	59·0
Silt		6·6		4·2		4·0		3·8	3·6	1·1	1·0	0·9
Clay		17·9		19·7		22·3		25·7	29·6	2·6†	3·4†	6·4†
Loss on Acid Treatment		2·0		26·7		23·3		13·4	6·5	0·4	0·5	0·5
Moisture		3·6		4·0		4·9		4·8	5·1	0·6	0·5	1·0
Chemical Data—												
Organic Carbon	C	1·31		0·69		0·42		0·31	0·15	0·47	0·22	0·19
Nitrogen	N	0·086		0·048		0·029		0·022	0·016	0·024	0·014	0·013
Phosphoric Acid	P_2O_5	0·021		0·015		0·011		0·010	—	0·012	0·008	—
Potash	K_2O	0·64		0·59		0·62		0·70	—	0·14	0·14	—
Sodium Chloride (from Chlorine)	NaCl	0·035		0·178		0·216		0·219	0·224	0·007	0·010	0·013
Total Soluble Salts		0·07		0·29		0·37		0·39	0·41	0·04	0·05	0·11
Exchangeable Bases—		m.e.%	x	m.e.%	x	m.e.%	x					
Calcium	Ca	14·55	69	8·51	46	3·43	20	—	—	—	—	—
Magnesium	Mg	4·16	20	5·83	32	7·33	43	—	—	—	—	—
Potassium	K	1·82	9	0·73	4	1·01	6	—	—	—	—	—
Sodium	Na	0·41	2	3·24	18	5·26	31	—	—	—	—	—
Total Bases		20·94	100	18·31	100	17·03	100	—	—	—	—	—

x = Percentage Composition of the Bases. † = Values for Silt and Clay Interpolated from Old British Units.

		Hd. Allen. Veitch Experimental Farm.								Hd. Allen. Veitch Experimental Farm.					
Soil No.		1870		1871		1872		1873		1878		1879		1880	1881
Depth		0–4″		4–9″		9–18″		18–27″		0–4″		4–9″		9–18″	18–27″
Horizon		A		A		B		B		A		A		B	B
Reaction	pH	8·7		9·0		8·9		8·8		7·5		8·5		8·7	8·6
		%		%		%		%		%		%		%	%
Calcium Carbonate		5·1		12·5		30·1		30·9		0·01		0·23		6·5	12·6
Mechanical Analysis—															
Coarse Sand		23·4		20·6		16·3		18·0		41·3		33·7		26·7	22·8
Fine Sand		49·1		44·5		31·0		30·1		45·3		37·5		27·6	22·7
Silt		4·6		4·7		3·3		2·3		4·5		4·4		4·2	2·7
Clay		13·2		12·7		14·1		15·0		7·7		19·6		28·3	32·4
Loss on Acid Treatment		7·0		14·3		32·3		32·8		0·4		1·1		7·7	13·7
Moisture		2·8		3·3		4·3		3·6		1·1		3·7		5·8	6·9
Chemical Data—															
Organic Carbon	C	0·69		0·67		0·38		0·25		0·36		0·37		0·32	0·20
Nitrogen	N	0·051		0·050		0·023		0·012		0·023		0·030		0·029	0·018
Phosphoric Acid	P_2O_5	0·021		0·022		0·014		0·011		0·016		0·018		0·022	0·019
Potash	K_2O	0·56		0·56		0·56		0·53		0·25		0·56		0·78	0·81
Sodium Chloride (from Chlorine)	NaCl	0·063		0·061		0·124		0·143		0·016		0·043		0·086	0·145
Total Soluble Salts		0·16		0·18		0·28		0·32		0·04		0·13		0·19	0·28
Exchangeable Bases—		m.e.%	x	m e %	x	m.e.%	x	m.e %	x	m.e.%	x	m.e.%	x		
Calcium	Ca	8·36	54	5·34	38	2·36	21	1·73	17	3·57	57	5·01	36	—	—
Magnesium	Mg	4·49	29	4·50	32	3·53	31	2·77	28	2·15	34	6·35	45	—	—
Potassium	K	1·34	9	1·47	11	1·24	11	1·10	11	0·35	6	0·78	5	—	—
Sodium	Na	1·28	8	2·70	19	4·23	37	4·33	44	0·22	3	1·96	14	—	—
Total Bases		15·47	100	14·01	100	11·36	100	9·93	100	6·29	100	14·10	100	—	—

x = Percentage Composition of the Bases   m.e.% = Milligram Equivalents per 100 Grms. Soil.

		Hd. Cadell. Sect. N.								County Hindmarsh (Milang).			
Soil No.		2138		2139		—	2140		2141	1974		1975	
Depth		0–4"		4–9"		9–36"	36–66"		66–85"	0–9"		9–18"	
Horizon		A		A		B	BC		C	A		B	
Reaction	pH	8·7		8·7			8·8		8·8	7·2		7·0	
		%		%			%		%	%		%	
Calcium Carbonate		5·00		6·61			10·5		25·4	0·01		Nil	
Mechanical Analysis—						9–30" Solid Limestone. 30–36" Heavy Rubble.							
Coarse Sand		36·2		32·3			6·1		5·0	57·7		44·6	
Fine Sand		41·3		43·9			23·9		20·9	30·8		19·0	
Silt		4·7		4·7			6·3		4·3	2·1		1·6	
Clay		7·9		7·7			43·6		30·4	7·2		29·8	
Loss on Acid Treatment		6·7		8·4			11·6		31·0	0·5		0·9	
Moisture		2·2		2·5			10·9		8·9	0·6		3·3	
Chemical Data—													
Organic Carbon	C	1·49		1·41			0·11		0·22	0·72		0·65	
Nitrogen	N	0·080		0·081			0·020		0·014	0·029		0·030	
Phosphoric Acid	P_2O_5	0·049		0·050			0·039		—	0·008		0·008	
Potash	K_2O	0·52		·0·50			1·65		—	0·18		0·76	
Sodium Chloride (from Chlorine)	NaCl	0·007		0·021			0·406		0 419	0·013		0·018	
Total Soluble Salts		0·10		0·14			0·62		0·62	0·06		0·06	
Exchangeable Bases—		m.e %	x	m.e. %	x		m.e. %	x		m e. %	x	m e %	x
Calcium	Ca	10·34	73	9·11	63		2·78	13	—	2·69	48	4·58	25
Magnesium	Mg	2·41	17	3·74	26		6·80	31	—	1·96	35	8·10	45
Potassium	K	1·15	8	1·23	8		4·14	19	—	0·25	4	1·22	7
Sodium	Na	0·21	2	0·40	3		7·99	37	—	0·75	13	4·05	23
Total Bases		14·11	100	14·48	100		21·71	100	—	5·65	100	17·95	100

x = Percentage Composition of the Bases. m.e % = Milligram Equivalents per 100 Grms Soil.

		Hd. Pyap. 1 Mile North of Pyap West.				Hd. Monarto (Monarto South).			
Soil No.		2350	2351	2352	2353	2330	2331	2332	2333
Depth		0–12"	12–24"	24–36"	36–44"	0–3"	3–10"	12–24"	24–29"
Horizon		A	AB	B	C	A	A	B	B
Reaction	pH	8·5	9·0	9·1	9·0	8·5	8·4	8·2	8·4
		%	%	%	%	%	%	%	%
Calcium Carbonate		0·14	0·42	3·71	1·21	—	—	—	—
Mechanical Analysis—									
Coarse Sand		42·2	40·8	35·3	40·6	38·2	39·0	14·7	15·3
Fine Sand		47·0	45·1	43·5	43·5	45·0	44·9	14·5	16·1
Silt		3·5	3·3	2·3	1·5	7·5	5·7	4·8	4·9
Clay		6·0	8·9	13·0	12·2	7·0	8·4	53·8	51·3
Loss on Acid Treatment		0·4	0·8	4·3	1·7	0·5	0·5	1·5	2·9
Moisture		0·7	1·1	1·5	1·3	1·2	1·4	11 ·4	10·7
Chemical Data—									
Organic Carbon	C	0·33	0·24	0·13	0·10	0·82	0·57	0·27	0·29
Nitrogen	N	0·024	0·020	0·013	0·011	0·039	0·026	0·023	0·021
Phosphoric Acid	P_2O_5	0·018	0·013	0·023	—	0·018	0·017	0·014	—
Potash	K_2O	0·24	0·23	1·25	—	0·25	0·32	0·39	—
Sodium Chloride (from Chlorine)	NaCl	0·005	0·016	0·038	0·058	0·008	0·013	0·185	0·214
Total Soluble Salts		0·02	0·08	0·15	0·17	0·03	0·04	0·29	0·34

	Hd. Mindarie. Sect. 48.			Hd. Mindarie. Sect. 43.		
Soil No.	322	323	324	331	332	333
Depth	0–9"	9–18"	18–27"	0–9"	9–18"	18–27"
Horizon	A	B	B	A	B	B
Reaction pH	8·4	8·8	8·9	7·3	7·8	8·6
	%	%	%	%	%	%
Calcium Carbonate	1·21	9·84	22·3	0·01	0·02	1·14
Mechanical Analysis—						
Coarse Sand	26·7	22·5	15·3	29·1	28·6	26·1
Fine Sand	45·2	31·2	21·5	66·2	65·7	59·0
Silt	6·5	6·2	1·9	0·3	0·6	0·6
Clay	16·9	27·0	33·2	2·8†	3·8†	11·5†
Loss on Acid Treatment	2·1	11·1	24·2	0·4	0·3	1·9
Moisture	2·5	3·5	4·1	0·5	0·6	1·6
Chemical Data—						
Organic Carbon C	0·90	0·43	0·73	0·24	0·11	0·13
Nitrogen N	0·063	0·039	0·032	0·016	0·010	0·012
Phosphoric Acid P_2O_5	0·031	0·028	—	0·006	0·005	—
Potash K_2O	0·61	0·95	—	0·10	0·13	—
Sodium Chloride (from Chlorine) NaCl	0·021	0·142	0·249	0·010	0·010	0·016
Total Soluble Salts	0·07	0·23	0·46	0·04	0·04	0·07

† = Values for Silt and Clay Interpolated from Old British Units.

CALOPRYMNUS CAMPESTRIS. ITS RECURRENCE AND CHARACTERS.

By H. H. Finlayson,
Honorary Curator of Mammals, South Australian Museum.

[Read October 13, 1932.]

Plates VII. to IX.

Introduction.

In September, 1931, the writer received(1) from Mr. L. Reese, of Appamunna, in the far north-east of South Australia, a skin and skull of *Caloprymnus campestris*, the first to be taken since the three original specimens on which Gould founded his description of the species in 1843. After 90 years the reappearance of this mammal, unrepresented in any Australian collection and long since thought to be extinct, was as gratifying as it was unexpected, and called for prompt action in adding by personal observation in the field as much as possible to the very imperfect accounts of its natural history which have so far been given. Accordingly, in December, the writer proceeded to the scene of the first occurrence, and in four weeks' work there met with considerable success both in obtaining further specimens and in collecting data on the general economy of the animal.

This success was very largely due to the cordial co-operation of Mr. Reese, whose services are hereby gratefully acknowledged.

Distribution.

The locality from which the first specimen was taken in August, 1931, was near Coongcherie water hole, about 18 miles south of Clifton Hills Station on the lower Diamantina in South Australia, in lat., approximately, 26° 32′ south. As a result of investigation following the first record its proved distribution may be extended over a large area of the eastern portion of the Lake Eyre Basin, specimens and reliable records from observers personally known to the author having been obtained from as far south as Lake Harry and as far north as Coorabulka in South-West Queensland. The north and south limits of its range, as at present ascertained, are, therefore, approximately, lats. 23° 40′ and 29° 21′ south. No records have so far been obtained west of Lake Eyre and the Kallakoopah, and the furthest easterly occurrence is at Innamincka, on the Barcoo, in long. 140° 49′ east. The area thus defined is referred to in the sequel as the "proved" area and is indicated on the map(2) (fig. 1).

The exact locality from which Sir George Grey's original specimens came is, unfortunately, not known, Gould, in 1843, simply stating (quoting Grey?) that "it inhabits the stony and sandy plains of the interior of South Australia." If the assumption is made that the specimens were taken at least a year prior to the publication of Gould's description in London, in 1843, it might appear that they came from a district considerably south of the lowest point of the "proved" area on the map, since at that time no official parties had penetrated it. The most northerly and north-easterly points reached by Eyre in his third expedition, in 1840 (Eyre's

(1) See Trans. Roy. Soc. S. Austr. (1931), vol. lv., p. 162.

(2) For assistance in compiling this map I am indebted to Mr. C. T. Madigan, of the University of Adelaide, and to Mr. E. J. Kenny and Mr. L. C. Ball, of the Geological Surveys of N.S.W. and Qld., respectively.

lookout and Mount Hopeless), lie on its southern fringe, but in the appendix on the fauna in his "Expeditions into Central Australia" no mention is made of the animal, as would surely have been the case had he obtained the three specimens

Fig. 1.
Map, showing distribution of *Caloprymnus campestris.*

which ultimately found their way into the British Museum. Though the place of origin of these specimens is a matter of considerable interest, it has now become too speculative to be followed further here.

The distinctive physical features of the area in which its presence is now proved are produced by combinations of north and south sandridges, claypans,

and gibber plains. To the north and south of the proved area the extension of this environment is not great, but elsewhere, both east and west, similar combinations occur without fundamental alteration[3] of ecological conditions, and it is possible that careful field work, particularly on the gibber plains which stretch north and west from Lake Eyre to the Central Australian border, might result in a great extension of its known range. The difficulties of testing this by personal observation are, however, very great owing to the huge areas involved and the waterless nature of much of the country, and enquiry is hampered by the sparse occurrence of the animal itself and the disappearance of the native blacks. All evidence obtained from whites in this indirect way, moreover, must be accepted with great caution, as on the fringes of the area recently examined (though not within the area itself) species of *Bettongia* and *Lagorchestes* occur which are so similar to *Caloprymnus* that in popular estimation they call for no discrimination from it.

The single record of *Caloprymnus* in the literature, since the taking of the original specimens, is that of Tate [Trans. Phil. Soc. S. Austr., viii., p. 124 (1878)], who claimed it as a common form on the Bunda Plateau at the head of Great Australian Bight. The locality is 400 miles from the site of the present occurrence and presents very different features. Tate, apparently, took no specimens of the animal and produced no evidence in support of his identification, and such details of its habits as he gives are more applicable to *Bettongia lesueuri* or *B. penicillata,* both of which probably occurred in the area at that time. Although the possibility of the occurrence of *Caloprymnus* on the Nullarbor Plain and adjacent tracts is not to be altogether discounted, it would seem very probable that Tate was mistaken. Recent enquiry amongst the blacks by Mrs. Daisy Bates, of Ooldea, and Mr. A. G. Bolam, of Kingoonya, have produced no definite results. The blacks profess to recognise photographs of *Caloprymnus,* but as different individuals apply different names to it, and as the same individuals use different names at different times, their testimony is of little value. One point of interest, however, has been established by Mrs. Bates in these enquiries, namely that the word "Weelba," which Tate quoted as the aboriginal name for his "*Caloprymnus,*" is of legendary significance only and denotes a mythical Rat Kangaroo whose burrowing activities, long ago in the "Dream Times," created the sandhills as a by-product. The name is not applied to any living species.

In the "proved" area several names are current amongst the remnants of the former tribes. The Yalliyandas call the animal Oolacunta; the Yaurorkas, Coorgee; and the Dieries, Wirtiree. In recent years the Wonkonguroos, an off-shoot of the Aruntas of the centre, have drifted south-west on to the Lower Diamantina and have largely replaced the Yalliyandas. It is of interest that they have adopted the Yalliyanda name Oolacunta for the animal, and some accomplished hunters amongst them state emphatically that in the country which they have left (the southern portion of Simpson's Desert) *Caloprymnus* does not occur.[4]

In ordinary years the Lake Eyre Basin is a most unattractive area from the point of view of the mammal collector, and the disappearance of *Caloprymnus* from scientific ken must be attributed rather to lack of systematic collecting than to any sudden change in the status of the animal in the fauna, following Grey's discovery. All the evidence obtained by questioning blacks goes to show that in

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(3) The flood plains of the Diamantina and the Coongie lakes of the Barcoo give a somewhat Eastern fascies to parts of the tract in question, but the area involved in these inundations is so small a part of the total inhabited by *Caloprymnus* as to prevent one laying much stress upon them as factors influencing distribution.

(4) This is the more probable, as the absence of gibber plains from this area has recently been proved by Madigan's aerial reconnaisance. See Proc. Roy. Geog. Soc. S. Austr. Branch, 1928-29.

all probability it has had an uninterrupted tenure of the country, but it is equally certain that in normal times its numbers are small, since men like Mr. Reese, whose opportunities for observation are practically continuous throughout the year, affirm that in thirty-five years they have seen no more than twenty specimens.[5]

It is significant, too, in this connection that in the whole of the very considerable literature on the exploration of the Lake Eyre Basin, there is no unequivocal reference to the animal.

At the time of my passage through the area, conditions as they bear upon animal life were very favourable and quite supernormal as compared with average conditions over a series of years. A period of seven years of drought had been broken, and vegetation had been restored on a comparatively lavish scale. All species of mammals were undergoing a quick increase in numbers, and rodents especially had assumed plague proportions. Most of the specimens of *Caloprymnus* were obtained, and the bulk of the observations upon it were made, on two flats lying east and west of Cooncheric Sandhill. In general features they represent a transition belt between the true gibber plains and the loamy flats. Though stony, they present no expanse of pavements such as characterise the former, and vegetation is not reduced to vanishing point as it is there. There is a fair sprinkling of plants, particularly of species of *Kochia, Atriplex, Bassia,* and *Eremophila,* though always widely spaced and never forming communities sufficiently dense to afford much shelter even to the smallest mammals. Here and there, at long intervals, occur little clumps of the so-called cork wood *(Hakea Ivoryi),* here a stunted tree of 10 or 15 feet.

The numbers occurring in this particular locality were very considerable. In the course of a week's riding on the two flats over an area of perhaps 20 square miles, 17 Oolacuntas were sighted. This, however, is no index to the density of its occurrence elsewhere, as in some other tracks presenting very similar features few or none were seen. It is possible that the increase in its numbers which has taken place since the drought is yet in its early stages, and that if conditions remain favourable its distribution may become more even and more dense. All the evidence obtained so far goes to show that its distribution at present is highly discontinuous but that it follows in a general way the fringes of the gibber plains, where conditions are as described. Although tracks were occasionally seen crossing the sandhills, it appears to spend little time in them and does not nest there.

Habits.

Although its mode of occurrence in isolated areas might be thought favourable to the development of a gregarious habit, this is by no means so. On the contrary the animal appears to be exceptionally solitary, since all those seen, both males and females, were put up singly, and on no occasion was a female accompanied by an independent young one. It is remarkable that *Caloprymnus* is the only terrestrial mammal[6] of the area which has not adopted a fossorial habit. It retains the primitive nesting habit of the *Potoröinae* in spite of its apparent inadequacy in a shelterless region of intense heat and intense illumination. The nest,

(5) Regret may here be expressed that the splendid work of Professor Wood-Jones on South Australian mammals, involving probably the most prolonged and extensive enquiry ever undertaken in this field in Australia, was not rewarded by the re-discovery of the animal. In 1924 he was within an ace of so doing, as Mr. L. Reese in that year gave him some account of the animal which I have now shown to be *Caloprymnus;* but as no specimens were forthcoming and he was not free to undertake the field work necessary for its identification, the matter lapsed.

(6) With the exception of *M. rufus,* which however spends the heat of the day camped in the shade of the timber near the channels, and possibly of *Choeropus,* about which little information is as yet available.

however, is a modified one built into a shallow excavation, frequently under a cotton or saltbush, but quite often in a most exposed situation well away from any shrubs of size. The excavation takes the form of a circular pan, 10″ in diameter and 4″ deep, with almost vertical walls cut away on one side to form a shallow entry and exit passage. The cavity is lined with leaves and grasses, and when it is situated in the open it is thatched by laying twigs and grass stems across the top and fixing them in position by interlacing them with stumps of plants formerly growing round the hole. The site appears always to be chosen with a view to a sufficiency of small growth round the nest to provide the thatch, which is evidently not carried to it. The blacks say that if the animal is frequently disturbed it deserts the nest and builds again elsewhere; many of the nests examined by me showed well-defined pads radiating out in several directions and apparently indicating a tenancy of some duration. Nevertheless, the whole structure has an air of impermanence and crudity very different from that of some of the other Bettongs, and this impression is heightened by its extraordinary habit of protruding its head through a gap in the thatch for purposes of observation. This habit is consistently vouched for by the blacks, who capture the animal by first ascertaining the direction in which the opening faces, and then, if the wind is suitable, creeping up from the opposite side and laying their hands, or a coolamon, over the top. Two specimens were actually obtained in this way by a Yalliyanda man during my stay at Cooncherie.

Observation of the undisturbed and unsuspecting animal has not been possible, and such impressions of its appearance and mannerisms as have been gained have resulted from chance encounters and from watching the animal while galloping it down. Most of the specimens were got in this way, six horsemen participating. The procedure adopted was to ride over a chosen area of the plain in extended order till an Oolacunta was put up. The nearest rider then galloped it towards the sandhill, while the rest of the party remained in a group. Before reaching the sandhill the animal was headed off by the pursuer and returned on its tracks towards the party; when the first horse began to flag it was replaced at a suitable moment by a fresh one, and so on. The performance of the animals coursed in this way varied somewhat, young males giving a better account of themselves than females, but in every instance a turn of speed was developed quite surprising in so stockily built an animal. This, of course, was particularly noticeable at the beginning of each chase, and the end of the first lap was always a moment of considerable excitement, as the heading process called for the utmost from the horses, and if not turned at this point the Oolacunta gained the sandhills and usually escaped.

The gait at this speed is distinctive and appreciably different from that of the *Bettongia* species and of *Aepyprymnus,* though the differences do not lend themselves to easy definition. It moves at an easy, uniform stride, which was not modified in character at any stage of the chase; the trunk is carried leaning well forward, and the tail is almost straight. In connection with its gait a very remarkable characteristic becomes apparent on inspection of the tracks, namely, that when moving at speed the feet are brought down rather widely separated from side to side and *one in advance of the other.* Unfortunately, the tracks made by those animals actually observed on the move were too indistinct to be of value, the ground being stony and dry, but on the claypans, Oolacunta tracks made during the last wet, were common and were of two types. When the animal is moving on all fours, using the tail as a support, the track is the one normal in all macropods (fig. 2A). But when the manus and tail are no longer impressed and the animal resorts to saltation, the tracks take the form shown in fig. 2B, the right toe being brought down well in advance of the left, and with its long axis in the line of advance, whereas its fellow is rotated outwards through about 30°. Each pair of

imprints is identical, and there is no alternation of right foot with left in the advance. All tracks examined showed the features described with little modification, except in the length of the stride, and one particularly well-defined track crossing a claypan yielded the following measurements:—The antero-posterior interval separating the base of the right toe from the base of the left was 6″; the lateral separation, 1″; and the length of stride, from the apex of toes in two sets of imprints, 30″.

These peculiarities of the tracks are, of course, well known to the blacks, and before any were seen by the writer one of the Wonkonguroo hunters, who was familiar with the Kanunka *(B. lesueuri)* in the Mickerie country, pointed out as a great marvel how two animals so alike as the Oolacunta and Kanunka should make tracks so different. He drew diagrams in the sand illustrating the differences; *B. lesueuri* making (as is well known) normal macropod tracks in which the toes are placed close together, nearly parallel, and with heels and toes opposite one another across the midline. Being aware of this asymmetry in the tracks before the living animal was seen, it was a matter of great interest during the subsequent encounters to correlate it by observation with the gait of the animal while on the move. No definite results were so obtained, however, as the thin pale legs fade out in a remarkable way against the yellow-grey background, and the

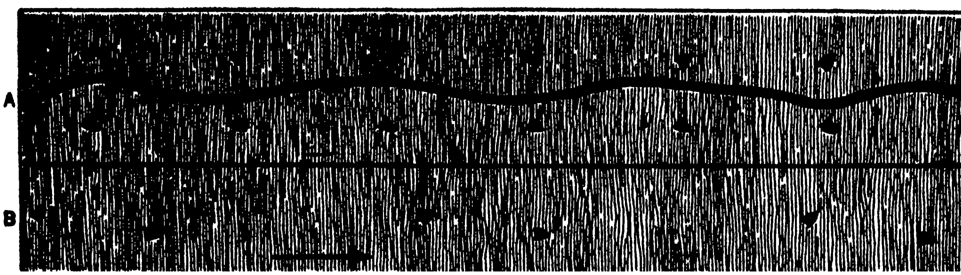

Fig. 2, A and B.
Diagram of tracks of *Caloprymnus campestris.*

difficulties of close observation on so small an object, from a galloping horse, are also considerable.

None of the Oolacuntas coursed showed any inclination to dodge or double; they kept direction with great constancy till headed by the horse, and then turned without spectacular bounds, such as are recorded for *Lagorchestes,* sp. Far more remarkable than its speed is the endurance of the animal. The first specimen taken, a young male, ran twelve miles and wore down two horses before he was finally brought to a standstill with a third, and all this under such adverse conditions of excessive heat and rough going as to make it almost incredible that so small a frame should be capable of so immense an output of energy. Each of the seven examples secured by this method persisted to the very limit of their strength and, quite literally, they stopped only to die.

Later an adult female and large-furred pouch young were obtained undamaged from a nest, and these specimens were kept alive for a short time and furnished the only photographs of the living animal which were obtained. Their behaviour when handled was mild and gentle, and unlike the other Bettongs they made no attempt to bite, but voiced their protest with the only sound noted at any time in connection with the animal—a harsh aspirate sound, little characteristic and similar to that made by many other marsupials of both suborders. The animal

has no characteristic smell and the only ectoparasite noted was a sparsely occurring louse, not yet examined.

The stomach contents of all specimens obtained were examined, but without definite findings. At this time of the year the animal appears to be a night feeder, and as most of the specimens were got towards the middle of the day, little undigested material remained in the stomach. The accounts of its feeding habits given by the blacks, and several other items of evidence, however, would point to its being largely phytophagous, or at least less rhizophagous than *Bettongia, Potoröus,* and *Aepyprymnus.* In this connection, too, it may be noteworthy that the teeth in all the skulls show a heavier incrustation than in the other genera. It appears to be quite independent of surface waters, since these are quite absent from the greater part of its range, and when they do occur there is no evidence that any use is made of them. Five miles from the area where most of the specimens were secured is a semi-permanent waterhole with the usual gently shelving clay margins; no tracks of *Caloprymnus* were there, however, although the water had been there for many months. It is curious that the animal should shun the sandhills, since the chief succulent plants of the district, *viz.*, the Parakeelia and Munyeroo, which might be thought its readiest means of acquiring a water intake, occur very sparsely, if at all, on the flats.

The seasonal aspects of reproduction in *Caloprymnus* would appear to be much the same as those of *Bettongia lesueuri,* as given by Wood Jones (Mammals of S. Austr., pt. ii., p. 212), since of the four adult females obtained in December, three possessed large, furred and partially independent pouch young of a total length of 375, 353, 318 mm., respectively—a very uniform development. The usual irregularities, however, occur, since one adult female in December had a naked pouch embryo of 50 mm., and gave no evidence of having recently suckled larger young. Further, the original specimen obtained by Mr. Reese, in August of the same year, was also an adult female with a pouch young as large as any seen in December, and again in June of this year three females taken by the blacks at Mulka possessed young in widely different stages of growth. Probably the polyoestry proved by Flynn for *B. cuniculus* in Tasmania is common to the whole subfamily. In no case was more than one embryo present in the pouch, but in one female, two of the total four mammae were functioning.

The data at present available are quite insufficient to give reliable information regarding the normal sex ratio of the species, and as already mentioned the methods adopted in obtaining a considerable proportion of the specimens tend to give females rather than males; yet even with these reservations, it is certainly curious that of the eighteen specimens[7] examined thirteen should be females.

External Characters.

Although so little has previously been known of the distribution and general economy of the animal, the three original specimens in the hands of Gould, Waterhouse, O. Thomas and Bensley have yielded a sufficiently full account of its characters to establish its systematic position. Having been based, in large part, on filled skins, however, they are misleading in some particulars, and occasion is here taken to correct them and to add further detail which has been obtained by observation and measurement of a series of developmental stages in the flesh.

The series available (Table 1) does not include a fully adult male, but there can be no doubt that the animal is one of the smallest of the *Potoröinae* and is inferior in most of its linear dimensions and in weight to all the species of the subfamily, with the possible exception of the little known *Potoröus gilberti* and *P. platyops.* The absence of an adult male is unfortunate, as it leaves unsettled

[7] For opportunities of examining five of these taken since my return from the district, I am indebted to Mr. C. W. Brazenor and the authorities of the National Museum, Melbourne.

the interesting question of the relative size of the sexes. The measurements of the aged male in the British Museum given by Thomas are taken from a filled skin and, except for the pes, are, therefore, of little use for comparison. The foot length given, however (21 mm.), is only 2 mm. in excess of that for a male in the present series at the P^3M^2 stage, from which it may perhaps be inferred that the maximum dimensions attained are not greatly in excess of those quoted in the Table. If this is so, then the female is probably larger than the male, as I have recently shown to be the case with *Aepyprymnus*, and as occur in many genera of *Phalangeridae*. If the stage of dentition is taken as a criterion of the general development of the animal, *Caloprymnus* appears to exhibit individual variations in size considerably greater than anything I have been able to observe in series of *Bettongia, Aepyprymnus*, and *Potoröus* culled from a restricted locality. But it is possible that interruptions in the tooth succession are responsible for some (though not all) of the anomalies which occur.

Thomas states that the form is slender and delicate. Skins may be made to appear so perhaps, but there is little in the appearance of the animal to distinguish it in this regard from the Bettongs. The long tail and neatly-formed pes may merit these terms, but the body is thick and even bloated in older animals and the blunt head and short neck quite destroy any impression of slenderness. In general shape, the animal is reminiscent of *Aepyprymnus.*

The head (pl. viii., fig. 1) presents several strongly-marked characters, which confer upon it a striking physiognomy sufficient to distinguish it at once from all its allies. In a frontal view (pl. viii., fig. 2) its outlines are such as might be inferred from the shape of the skull—the muzzle being very short and conical and tapering rapidly from an unusually broad interorbital region. It is the profile view, however, which is so strange and so characteristic and for which one is quite unprepared by the cranial outline. In this aspect the muzzle is abruptly and vertically truncated, and the upper lips, which are enormously developed, swell outwards beyond the level of the rhinarium, and in so doing add greatly to the curious bluff expression of the face. The nasal profile is strongly concave and rises rapidly to a markedly convex supra-orbital and frontal region—the condition is exaggerated as age advances, but it is always noticeable even in the sparsely furred pouch young. The rhinarium is large, naked, smooth or obscurely tesselated and nearly black in colour. It is broader than deep, its transverse diameter exceeding the vertical by $\frac{1}{3}$. At no stage does it show any sign of being cleft in the midline. The facial vibrissae are rather poorly developed, and submentals and interramals are apparently absent. The mysticials are flexed strongly forward; four which occupy the antero-superior corner of the set are black, but the remainder are white. The genals and supraorbitals are entirely black. The eye is prominent and staring, its pupil almost circular and very dark bluish-brown or black in colour. The lids are prominent and fleshy.

The ear is a remarkable feature and differs considerably from that of *Aepyprymnus, Bettongia,* and *Potoröus.* In the adult or subadult animal the auricle attains a length from the tragoid notch to the distal margin of 45 mm., and its maximum transverse breadth falls as low as 14 mm. It is thus longer and narrower than in any other animal in the subfamily. Its shape is peculiar in that it is deeply entroughed, the lateral margins are parallel for the greater part of their length, and the external surface of the pinna is indented by a shallow longitudinal sulcus. Its substance is thick and fleshy, and the inner naked portions are in most of the specimens pigmented black as in the *Macropodinae.* The sculpture of the cartilage is simpler than in the other three genera. The helix is well developed basally but has little distal extension as a marked feature. The antihelix is low and ill-defined and without accessory or associated processes. The tragus is well marked but small, and is separated by a very distinct notch from a

low anti-tragus from which springs a conspicuous tuft of light-coloured hairs. In life, the ear is apparently rather immobile. It is carried prominently, and as its base is not obscured by long fur on the crown of the head as in other Rat Kangaroos, it bears considerable resemblance to *Lagorchestes*. The ear was described by Gould, Waterhouse, and Thomas alike, as being short and rounded —a further example, if such were needed, of the difficulties which attend the description of soft parts from dried skins.

The fore limb is exceedingly small and feeble, the bones of its three segments weighing but 1 gramme, as compared with 12 grammes for the bones of the hind limb, and the combined lengths of the three segments in fore and hind limbs are as 1:3·1. In the manus (text fig. 3, A and B) the digital formula is $3>4>2>5>1$ but closely approximates to $3>4=2>5>1$ and as the attachment of the lateral digits to the metacarpus takes place at the same level on either side, the arrangement is a symmetrical one. The general condition is similar to that of *Bettongia lesueuri* but the manus is relatively smaller, the digits slighter and the ungual phalanx and its nail notably longer. The interdigital, thenar, and hypothenar pads are fused as in *Bettongia* to form a subtriangular cushion occupying the greater part of the palmar surface; the fusion of the basal pads is less complete, however, in *Caloprymnus* and the hypothenar element is indistinctly marked off by a shallow sulcus. The development of the cushion is greater than in *Bettongia* and in a lateral view of the manus it projects very prominently. The naked portions of the palm are pale horn-coloured and indistinctly granular, and the nails are pale horn-coloured and translucent.

The hind limb is long, but very slight in proportion to the bulk of the animal (pl. vii.), and with the gluteal portions little developed. The ratio of the length of head and body to hind limb is 1:1·03, which is about that prevailing in *Aepyprymnus* and *Bettongia*. Its most conspicuous feature is the relatively enormous size of the pes as compared with the femoral and median segments. It is characteristic of the hind limb of the arboreal *Phalangeridae* that the femoral segment is markedly dominant as regards length, and its relation to tibia and pes is expressed by the formula: Femur>Tibia>Pes. In *Phascolarctus*, for example. the ratios are 400:317:283. The evolution of the characteristic elongated pes of all the terrestrial *Macropodidae* appears to have been achieved largely at the expense of the ancestral phalangerine femur, since there is a marked reduction in the contribution of the proximal segment to the total length of the limb in all genera of the family. The segment ratios in the two subfamilies, however, are constantly different. In the *Potoröinae* the prevailing condition is that Pes>Tibia>Femur; this is true even in the short-limbed *Potoröus*,[*] and it is significant that in all species the relation of the tibia to the limb as a whole remains much as it is in the *Phalangeridae*. In the *Macropodinae*, on the other hand, a secondary elongation of the tibia results generally in a more specialized condition, expressed by Tibia>Pes>Femur. In the proportional constitution of its hind limb *Caloprymnus* not only exhibits the condition of the other *Potoröinae* but carries it to such an extreme as actually to reverse the numerical ratios of *Phascolarctus*. In a subadult male of the former the ratio, Femur:Tibia:Pes becomes 262:330:401.

The pes (fig. 3, C and D) is narrow, very elegantly formed, and in general appearance is reminiscent of the smaller *Matropodinae* such as *Lagostrophus* and *Lagorchestes*, rather than *Bettongia* and *Aepyprymnus*. Its proportions, however, are as in the other *Potoröinae*, and the ratio, Pes: 4th toe, is as 1: ·46—a value very constantly shown by all four genera and much higher than that shown by the *Macropodinae*. The fourth toe is strongly specialized in adaptation to the stony condition of much of the country over which it moves; in an inferior view

[*] Occasionally in old males of *P. tridactylus*. Pes = Tibia > Femur.

its first phalanx is very narrow, but at the second there is a sudden expansion owing to the development of a broad resilient pad, on which the crease line is much reduced or quite absent, and which continues without constriction to the base of the nail. The fifth toe is well developed, and the syndactylous toilet digits are about as in *Bettongia,* but are strongly reflexed distally so that their nails point almost directly upwards and not downwards or forwards as is usual. The interdigital pad is large, oblong, and lies slightly oblique to the long axis of the

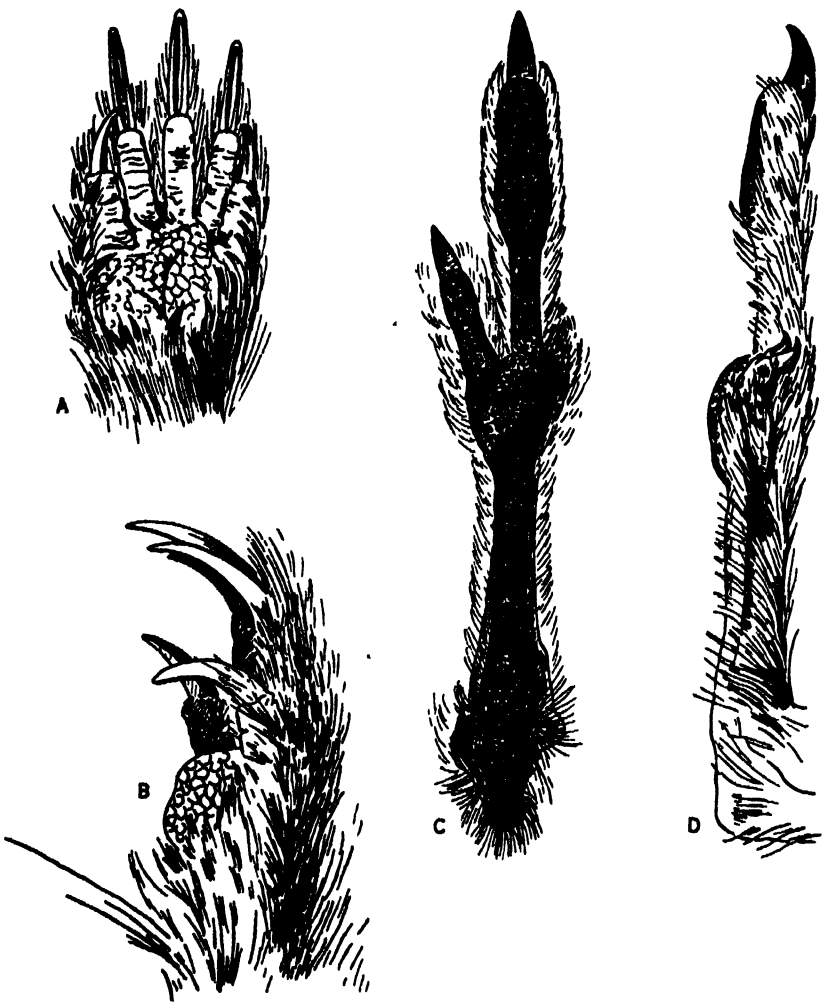

Fig. 3, A, B, C, D.
The manus and pes of *Caloprymnus campestris;* subadult male.
A and B, Right manus (x2) ; C and D, Right pes (x1).

foot. The entire extent of the plantar surface of the pes is quite naked and without infringement of hairs upon its margins. The sole is harder and tougher in texture than in *Bettongia,* is rather coarsely granular, and variably pigmented a dark slate or black, but this, like the pigmentation of the auricle, is subject to fading in spirit specimens. The nails are black and opaque. There is a marked and abrupt expansion over the infratarsal sesamoid.

The tail is very long, the ratio of its length to the head and body being 1·16: 1, and is thus longer than in any other member of the subfamily. It has little basal thickening, is circular in section and tapers very slowly to the end and is subcylindrical for the greater part of its length. Its distal portion has no modifications suggesting a prehensile function, and it is without either chevron callosities or the basal callous on the upper surface. The post sacral vertebrae in a subadult male number 24.

The cloaca (fig. 4, A and B) in both sexes is small and inconspicuous, with poorly developed margins but little raised above the general ventral surface. It is not surrounded by specialized bristles but from the inferior (caudad) margin, a fleshy club-shaped or subcylindrical process is developed similar to that of *B. lesueuri* but larger and more sharply demarked. In adults the process is 6 mm. long and pendant, but in four furred pouch young examined it is folded forwards

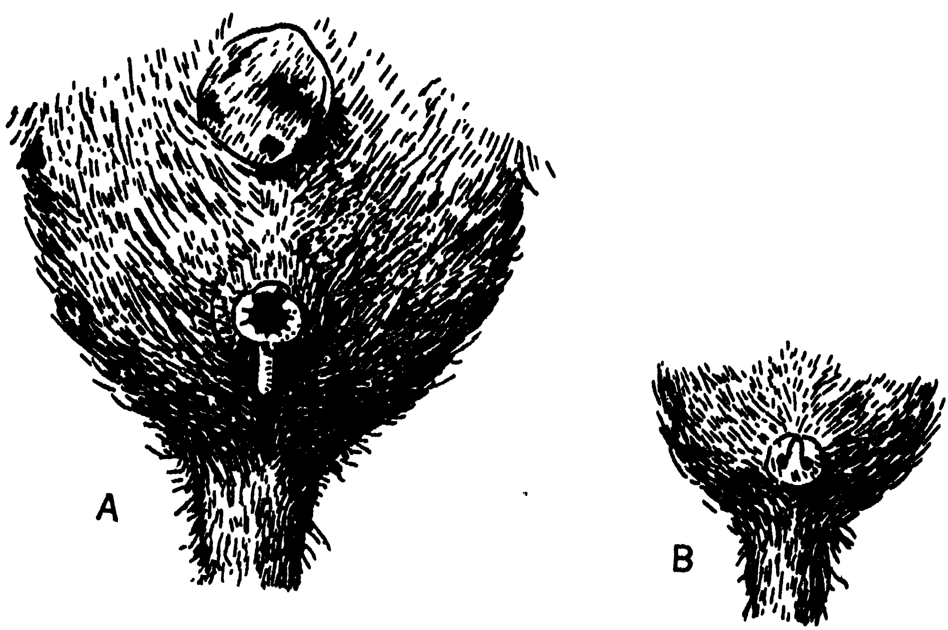

Fig. 4, A and B.
The cloaca of *Caloprymnus campestris*.
A, Subadult male; B, Female pouch young.

and adpressed so as to cover the orifice. The testes in the four subadult males are rather small, and the skin of the scrotum is unpigmented. In females the opening of the pouch is unusually far forwards, being somewhat anterior to the mid-point of the ventral surface; it has no anterior extension but is produced posteriorly almost to the cloaca. The mammary area is surmounted by four nipples, either one or two of which are functional.

Between the insertion of the fore limbs, sternal or gulo sternal in position is the naked area which has been noted in previous descriptions. It is present in all the specimens obtained, both male and female, and is quite distinct even in the furred-pouch young, though its boundaries become more sharply defined as age advances. There is a good deal of variation, apparently individual rather than sexual, in its shape and exact position, but it is commonly about 50 mm. long and 20 mm. wide, and roughly oblong or lozenge shape; its longitudinal extension is always much greater than its transverse. When incised the skin does appear to

be especially thickened or modified and to the naked eye it presents little evidence of a glandular function, being smooth, poreless and unstained by exudates. It is not surrounded by hairs specialized in colour or texture as in *Trichosurus, Petaurus,* and *Phascolarctus.* The peculiar swollen, almost goitred, appearance of the throat in one of the examples figured by Gould, was not presented by any of the present series.

PELAGE.

As the descriptions of Waterhouse and O. Thomas on this head may be applied without serious discrepancy to the skins now available, and as Gould's plate is on the whole an excellent representation of the animal, it will be unnecessary to give a detailed systematic description. It may be well, however, to restate the coat colours in terms of modern standards and to refer briefly to those pelage characters which tend to mark it off from its allies.

The longest hairs of the dorsum reach 35 mm. in length, and the coat, which is very soft to the touch, is dense and has a copious under-fur; a curious condition in an animal partially diurnal in habit and exposed throughout a large part of the year to excessively high day temperatures. There appears to be little seasonal variation in the coat. In the mid-dorsal region the fur presents five distinct colour zones. The under-fur (which is of about equal diameter throughout its length) is close to Ridgeway's "blackish slate" for its basal $\frac{2}{5}$ths. The median portion of equal length is about "cinnamon buff," and the terminal $\frac{1}{5}$th a rich blackish brown. The guard hairs in their basal $\frac{3}{5}$ths are "blackish slate," this is then succeeded by a narrow band of rich blackish brown, a broad subterminal band of "ivory yellow," and the extreme tip, which is finely pointed, is rich blackish brown, shading into black. The basal portions of the guard hairs are circular in section and of about the same diameter as the under-fur (·04–·06 mm.), but at the subterminal band there is a rather rapid expansion to a maximum of ·31 mm, and this light-coloured portion is quite opaque and is highly modified in shape, taking the form of a flattened blade ·13 mm. thick, tapering at both ends and distinctly grooved on one surface. In the mid-dorsal area, the sequence of the very pale subterminal band upon the dark brown zone affords a striking contrast when the fur is parted, but on the nape and sides the brown band tends to disappear, and on the rump the basal slate band, also, is much reduced. The ventral fur is creamy white distally, darkening to a very pale slate basally. In spite of these contrasted colour zones, the dominant impression conveyed by a general view of the animal at a little distance is of its extraordinary pallor, produced by the heavy uniform overlay of guard hairs carrying to the surface of the coat the broad yellowish white subterminal band. The arrangement of these bands is so close and dense on the dorsum that the brown and ochre tones in the deeper layers of the coat are quite obscured, and as their flattened surfaces possess a curious opaque nacreous lustre, a reflecting surface is produced more effective perhaps than in any other marsupial, except *Notoryctes.* O. Thomas gives the general colour as "grizzled sandy," but if the skins are viewed at such a distance that the component colours blend into a uniform whole (and this seems to be the rational procedure in determining a general colour) they approximate to Ridgeway's "light buff." Theories of protective and adaptive colouration have been carried to such lengths that one hesitates to adduce new instances of it, yet the resemblance of the pale buffy tones of the pelage to those which prevail in much of the country where the animal was observed, is too remarkable to be passed over without comment.

As is general throughout the subfamily, there is an entire absence of distinct body or face markings, but the ear which has generally been described as uniformly coloured, is strongly bicolor on its outer surface in all the specimens examined. A narrow area adjoining the anterior margin is clothed with short rather coarse

adpressed hairs of colour near to Ridgeway's "ochraceous tawny," but the remainder is rather sparsely covered with light cream, fluffy hair which fails to conceal the black epidermis; the areas involved and their condition is much as in *Aepyprymnus,* though the contrast is not so marked as in that animal. These pale fluffy hairs lengthen as they approach the base of the ear, where they finally merge with a prominent creamy white patch of similar texture having its origin at the intertragoid notch. In the profile view of the head this is a conspicuous feature; it is not present in any other of the *Potoröinae,* but in a reduced form is a familiar feature in many wallabies.

In the young animal the tail is covered with short adpressed hair, bright yellow above, paler below. The hairs on the upper surface are so sparse as to reveal the epidermis, but below they are plentiful, coarse, translucent and closely adpressed. In older animals most of the hairs of the upper surface are lost and the scales of the almost naked epidermis may then be seen to average 11 rows per centimetre, the under surface of the tail retains its dense covering through life, and its condition is exactly that of the typical wallabies and kangaroos. In one specimen only is the tail-tip white.

The hair tracts are much as in *Aepyprymnus*—cephalo-caudad and proximo-distad dorsally, ventrally a strongly marked central opposition ridge especially in females and a gular reversal. Seasonal, sexual and individual variation in pelage characters are but little evident. The closeness of grizzling and the colour is influenced somewhat by age, younger animals appearing more fulvous and less grizzled, owing partly to an inferior development of guard hairs and partly to a richer tone in the outer subterminal band and in the under-fur.

The furred pouch young is very like the adult in colour, such differences as occur being due chiefly to a scantier development of under-fur and to a light sprinkling of black hairs over the dorsum.

Skull Characters.

Eleven skulls have been examined (Table 2), representing stages from pouched young with incomplete incisor series to aged individuals with worn P^4M^4. The skull attains its maximum dimensions at an early dental stage, and in spite of the range of development represented, the series is a uniform one owing to the early setting of the suture lines into forms which are not much modified by increasing age; a peculiarity shown by all the *Potoröinae* and strongly contrasted with the marked time changes which are the rule amongst the *Macropodinae.* With the possible exception of *Potoröus platyops* the adult skull is the smallest of the subfamily, but at the same time is relatively the broadest and in general appearance is very different from all the related forms whose main quantitative inter-relations are summarized in Table 3.

Theoretical interest centres chiefly in the structure of the muzzle region and in the dentition.

The short, excessively broad narial chambers (fig. 5, A) constitute by far the most striking feature of the skull, and serve at once to distinguish it from all other *Macropodidae.* The condition at first sight suggests a highly specific modification for the housing of an enlarged ethmoturbinal. This may be partly so, but when the dimensions of the muzzle region in *Caloprymnus* are compared statistically with the rest of the subfamily the modification is seen to be rather less significant than it at first appears. If consideration be given to the relative size of the skulls of the different forms, it is seen that the brevity of the muzzle is exceeded in the central forms of *B. lesueuri* and its breadth is closely approached by *P. platyops.* The circumstance of the occurrence of a similarly enlarged ethmoturbinal in both *Caloprymnus* and *Potoröus* argues strongly against the adaptive character of this feature, since the two genera occupy the climatic extremes of

the continent, and there can be little doubt that it represents a primitive character carried over from the ancestral *Phalangeridae*. It may be noticed that amongst existing species of the last family, *Petaurus australis,* which according to Bensley

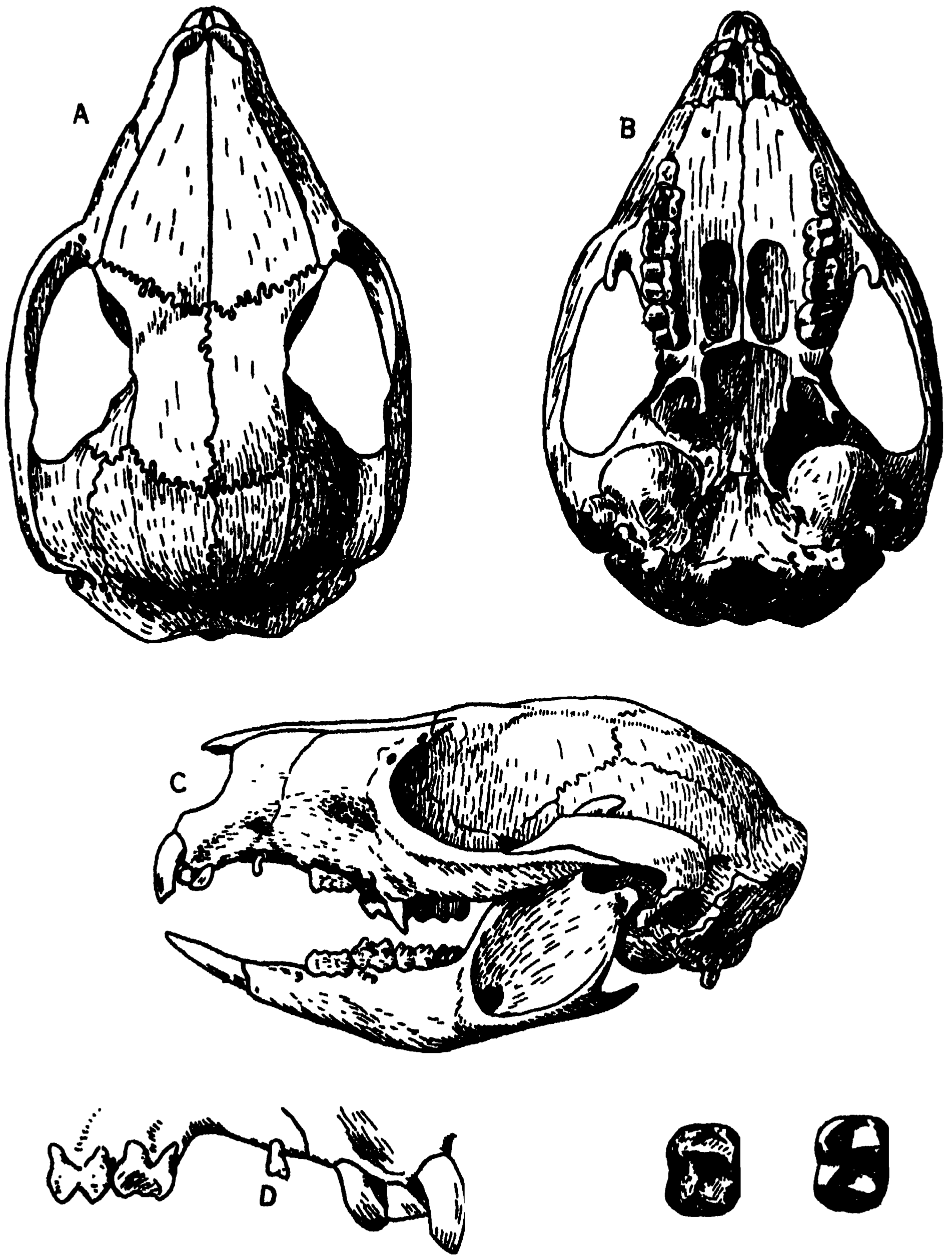

Fig. 5, A, B, C, D, E, F.

A, B, C, Frontal, palatal, and lateral views, respectively, of the skull of *Caloprymnus campestris,* an adult female (x2). D, Side view of anterior palate of an immature male, to show the vestigial diastemal tooth (x2·6). E, Left upper 2nd molar figured by Bensley (after Bensley). F, Left upper 2nd molar of a young male (x2·6).

should not be far removed from the root stock from which the *Potoröinae* sprung, presents features in its muzzle region distinctly recalling those under discussion.

The development of the nasal bones themselves is still more curious and more characteristic of the animal as a structural feature, than the chambers which they cover. They are of enormous size, and are so developed in all directions that the premaxillae, maxillae, lacrymals and frontals which in the other forms make appreciable contributions to the roofing of the nares are in *Caloprymnus* crowded out to the margins of the turbinal areas. Their breadth is immediately apparent on inspection of the skull, but their great length, while equally remarkable, is only brought out by comparative measurement. By expressing the length of the nasals as a percentage of the basal length of the skull it is seen (Table 3) that they are longer in *Caloprymnus* than in any other species except *Potoröus tridactylus*—a notable result in view of the general dissimilarity of cranial form in the two. The lengthening of the nasals is effected by an encroachment on the frontals, as is shown by the fact that the posterior margins of the former reach back as much as 6 mm. beyond a line joining the posterior lacrymal foramina. In all other species the nasals fall short of this line, usually by a considerable interval. The broadening of the nasals is definitely an age character, and the condition figured by Thomas and the still more extreme condition shown in fig. 5 A, in which their posterior border is almost transverse, is not shown by immature individuals; in these younger skulls the posterior margins are sinuous in varying degree.

The skull is further distinguished from all other *Potoröinae* by the uniform presence of an infrazygomatic process of the maxilla; the process is well developed and has an average projection beyond the lowest point of the malar of 4 mm. Although the process occurs in a rudimentary form in the larger phytophagous *Phalangeridae*, its presence as a notable feature in the structure of the zygomata is the exclusive possession of the *Macropodinae*, where it has evidently been developed in response to changes in the masticatory apparatus called forth by the adoption of a bulky herbivorous diet. That its presence in *Caloprymnus* rests on a similar functional basis and is correlated with the modifications of the dentition, is strongly indicated by analogy and by such information on its feeding habits as is available.[9]

Other minor points of distinction are to be found in the brain case, which is very small and globular with little tapering towards the interorbital region; in the temporal ridges which are strongly marked and in the anterior palatine foramina, which though variable have an average relative length considerably greater than in other rat kangaroos.

Underlying the many aberrant characters of the skull, striking though some of them are, there is, nevertheless, no lack of evidence to associate it in an unequivocal way with the *Potoröinae*. Apart from the testimony of the dentition, one of the most interesting links of relationship is afforded by the condition of the temporal region of the skull, where in *Caloprymnus* the squamosal makes a wide contact with the frontal, as it constantly does in every member of the subfamily. Throughout the Marsupialia the alternative condition of a contact between parietal and alisphonoid is the usual one, and the *Peramelidae* and *Potoröinae* appear to be the only constant exceptions. The feature effects a sharp cleavage between the *Macropodinae* and *Potoröinae*, as throughout the whole of the nine genera of the former I can find no exception to the alisphenoïd-parietal contact, which is generally characteristic also of the ancestral *Phalangeridae*.

The mandible is very much as in *Bettongia* and has a long slender coronoid, receding obliquely from the body of the ramus, as in all the subfamily. The condyle is not elongated transversely as in *P. tridactylus*, and the lower border of the body is not more convex than in other species.

(9) It must be admitted as an apparent anomaly, however, that *Aepyprymnus*, in which similar modifications of the molars occur, does not develop the process.

Dentition.

The dentition as shown by the British Museum specimens has been described and partly figured by O. Thomas and Bensley, and the phylogenetic significance of its characters has been assessed by the latter. Examination of the present series permits of slight modifications and additions to these accounts. P^4 takes its place shortly after M^3, and judged by the dimensions of the skull and the animal at the time M^4 is late in erupting, not early, as stated by Thomas in his diagnosis of the subfamily. Although no irregularities in the succession of P^4 with respect to the other teeth are presented, the entire development of the posterior arch may be delayed (as in *P. tridactylus)* so that animals which are old when judged by their general size, and their sutural and epiphysial conditions, come to have a juvenile dentition. Thus the skull of the largest examples obtained (fig. 5, B), in whcih the age characters of the nasals and temporal crests are more marked than in any others, is just at the tooth change and still lacks an M^4.

In the incisor series, canine and premolars, all the modifications listed by Bensley as being prototypal to the *Macropodinae* are to be seen. It may be noted, however, that the tooth which has been called a canine is usually erupted somewhat posterior to the premaxillary suture, and although its vestigial nature is attested by its great variability, yet in young skulls it is far from caniniform, since it widens distally to form a distinct cuspidate crown (fig. 6) and then resembles somewhat the bifid premolars of the simpler *Phalangerinae*. P^4, in its unworn condition, has in addition to the postero internal talon a distinct *antero internal* ledge which runs back nearly half the length of the tooth.

It was stated by Bensley that the upper molar teeth decrease gently in size backwards, but in the present series the condition is less primitive since in both upper and lower jaws $1<2>3>4$ as it usually is in *B. lesueuri*. The upper M^4 is a very small tooth in the two examples, in which it is fully erupted but unworn; it is tricuspid and triradical and the posterior lobe shows no bifurcation. The lower M^4 is larger but otherwise similar in character. Hypsodontism is shown by the outer cusps of the upper molars much more than by the inner cusps, and *vice versa* in the lower series, and the difference in height is rapidly accentuated by wear, so that as age advances the occlusal plane rapidly becomes oblique to that of the palate, as it does in the hypsodont section of the *Macropodinae* and to a lesser degree in *Aepyprymnus*.

The modifications of crown pattern away from *Bettongia* and towards the *Macropodinae,* although recognisable, are somewhat less evident than might be gathered from Bensley's description and figures. The tendency for the transverse ridges of the outer cusps of the upper molars and the inner cusps of the lower molars "to extend to the remaining cusps" is not greater than in unworn molars of *B. lesueuri* for example, and much less than in *Aepyprymnus,* and no unworn molar in the present series shows so extensive a development of the anterior transverse crest as in his pl. 5, fig. 19.[10] (Compare fig. 6, E and F.)

In all the specimens now examined the buccal cusps of the upper molars, and the lingual cusps of the lower series, make a much greater contribution to the transverse crests than their fellows on the opposite side. On the other hand, the longitudinal elements of the upper lingual cusps are strongly marked, and in particular that which proceeds from the posterior of them obliquely forwards towards the central valley of the crown is more prominent than in all the genera except *Aepyprymnus* and occupies about the same position as the "central connecting bridge" in *Macropus*. The resemblance of the newly erupted crowns to those of *Trichosurus* is striking.

(10) This may be partly due to the difficulty of representing vertical elements in a full crown view.

Although in no way affecting the claims of *Caloprymnus* to a prototypal position with respect to the dentition of the *Macropodinae*, it is of interest to note that *Aepyprymnus* in the perfecting of the transverse ridges, in the development of longitudinal elements, and in increased hypsodontism, has independently attained to a much more advanced position.(11)

In the relative length of its molar series, *Caloprymnus* exceeds all other *Potoröinae*.

Skeleton.

Comparisons instituted between the skeleton of a young male *Caloprymnus* and other members of the subfamily have not disclosed differences of importance. While individual variation is considerable, generic and specific differences in structure are slight and can be brought out adequately only by statistical treatment on series of skeletons at comparable stages, and these are not yet available.

Relationships.

Chiefly from an examination of the dentition, Bensley has shown that the subfamily *Potoröinae* of the catalogue of 1888, together with *Hypsiprymnodon*, comprises two groups of genera which are not only marked off from one another by characters which persist through considerable series of forms, but which actually represent diverse or even opposed lines of evolution. *Hypsiprymnodon*, *Bettongia*, and *Aepyprymnus* (6 stages) are characterised by the possession and increasing development of elaborate vertically fluted sectorial premolars, which show a progressive rotation of their long axis through 90° in response to a progressive shortening of the muzzle region, and *Potorous* and *Caloprymnus* in which the premolar is not fluted, has its long axis in line with the molar series and in which the trend through the three serial forms has been towards a progressive elongation of the muzzle.(12) Although both series retain many primitive *Phalangerine* characters and are sharply severed from the dominant subfamily, the *Macropodinae*, yet the second of them is distinctly more primitive than the first.

The special interest of *Caloprymnus* is twofold. On the one hand, it has taken no part in the elongation of the muzzle which is the particular evolution of *Potoröus*, and has acquired by adaptation to a new environment a series of specializations which while rendering it remarkably divergent from its best known living ally, *Potoröus tridactylus*, have brought it convergently, remarkably near the lower members of *Macropodinae*. On the other hand, of all the existing forms of both series it is the only one which tends even slightly to break down the isolation of the two subfamilies from one another, since alone of all the species it exhibits characters in its incisors, "canine," premolars and molars alike, prototypal to the *Macropodinae*.

The data which have now been gained by the recurrence of the animal and which are herein summarized, while confirming the presence of these prototypal characters, tend strongly also to emphasize its primitiveness, its essential identification with the rest of the *Potoröinae* and the fundamental nature of the cleavage of the two subfamilies, in features other than the dentition. In the latter connection, attention may again be drawn to the constant difference in the structure of the temporal region and in the segmental ratios of the hind limb. It is remarkable

(11) This comparison is based on Queensland examples of *Aepyprymnus* only, while Bensley's examination was probably confined to N.S.W. examples. It is possible that regional differentiation may have produced considerable changes in the dentition, as it has in *B. lesueuri* and *P. tridactylus*.

(12) Bensley created a new group or subfamily for the first series which he called the *Bettongiinae*, and restricted the old term *Potoröinae* to *Potoröus* and *Caloprymnus*. This arrangement, however, as Bensley admitted, was founded on a rather narrow base of characters and has not been widely used. In this paper the term *Potoröinae* is used in the older sense.

that the specialization of *Caloprymnus,* which in the living animal most strongly recalls the higher *Macropodinae,* namely, the perfection of its saltatory habit and performance, should have produced no modification in the primitive proportions of the hind limb, and the circumstance may argue the comparatively recent nature of this development.

The distribution of the animal as now ascertained, isolated as it is from that of the rest of the subfamily,[18] and restricted to a comparatively small area of strongly-marked physiographical and climatic features, is sufficient to account for its peculiar specific characters and is of the greatest value as affording a possible clue to the origin of the aberrant evolution which has sundered it so far from the existing species of *Potoröus.* The palaeontological testimony to the past distribution of Australian mammals is so incomplete that it is impossible to form a clear idea of the regional limitations of the various radiations or of the times and routes by which some of the families and genera have acquired transcontinental representation. The geological history of the Lake Eyre Basin, however, seems to be sufficiently known, and its past efficacy as an "active distributing centre" (in W. J. Gregory's phrase) sufficiently well attested, to justify the view that the evolution of *Caloprymnus* from the ancestral *Potoröus* postulated by Bensley, may have begun here.

During a lacustrine phase of relative humidity and bush vegetation, conditions well suited to the sedentary, local, sheltered life of *Potoröus* would be presented, and the subsequent desiccation which proved so disastrous to the already over-specialized *Diprotodon* might awake a successful response in a primitive and plastic form at the level of *Potoröus platyops,* culminating in the relatively perfect adaptations of *Caloprymnus* to the present extreme eremian conditions.

Where *Diprotodon* failed, *Caloprymnus* may yet succeed, but all the evidence of its physical structure is not more eloquent of changed conditions than its pathetic clinging to its flimsy grass nest, in a fiery land where a fossorial habit has become the main factor in survival.

TABLE I.

Flesh Dimensions of *Caloprymnus campestris* in mm.

	Teeth.	Head and Body.	Tail.	Chest.	Manus.	Nail of 3rd Digit.	Pes.	4th Toe.	Nail of 4th Toe.	Ear.	Rhinarium to Eye.	Eye to Ear.	Eye: Canthus to Canthus.	Weight in Grammes (approx.)
							♂							
1234	P^3M^3	272	333	125	21	10	119	55	14	45 x 19	26	21	—	850
1244	P^3M^3	282	317	—	22	11	117	56	14	42 x 15	29	21	12	850
1239	P^3M^3	263	307	130	21	11	112	51	13	44 x 15	27	22	—	850
1233	—	255	297	130	20	11	106	49	9 (worn)	42 x 13	26	18	—	637
1236	P^3MP^4	163	155	—	—	—	84	—	—	26 x 14	19	16	—	140
							♀							
1399	P^4M^3	—	377	—	—	—	115	—	—	—	—	—	—	—
1235	P^4M^3	275	340	150	20	10	106	49	13	41 x 15	28	23	13	1060
1237	P^4M^4	277	328	140	21	11	112	50	14	42 x 15	31	25	11	1060
1216	P^4M^3	254	320	150	18	11	104	48	13	42 x 15	28	24	12	1060
1242	—	263	310	125	20	11	108	49	13	41 x 16	26	22	13	743
1217	P^3MP^4	163	212	—	—	—	98	—	—	31 x 15	20	13	—	195
1238	—	—	180	—	14	6	96	42	10	30 x 14	21	16	—	135

(18) *B. lesueuri* occurs to the west and north-west of Lake Eyre, but no other species of the subfamily shares the proved habitat of *Caloprymnus.*

Table II.

Skull Dimensions of *Caloprymnus campestris.*

	♀					♂			
Number of specimen	1216	1217	1235	1237	1339	1234	1236	1239	1244
Dental condition	P^4M^3	P^3M^1	P^4M^3 (m^4)	P^4M^4	P^4M^3	P^3M^3	P^3MP^4 (m^1)	P^3M^3	P^3M^3
Greatest length	60·0	44·0	61·0	61·5	63·5	57·5	38 ca.	60·0	59·0
Basal length	52·0	35·0	52·0	52·5	54·0	49·0	—	50·5	51·0
Zygomatic breadth ..	39·0	27·5	38·0	40·0	40·5	36·0	—	35·5	36·0
Nasals length	26·5	16·5	28·0	27·0	29·5	24·0	16·0	26·5	27·5
Nasals greatest breadth	18·5	12·5	18·0	19·0	21·5	19·5	11·0	17·0	17·0
Nasals least breadth	6·5	5·0	7·0	9·0	7·0	7·5	5·5	7·5	7·0
Nasals overhang ..	5·5	2·5	4·5	5·5	4·5	3·5	—	4·5	4·0
Depth anterior nares	13·0	10·0	13·0	13·0	13·5	12·5	—	13·0	12·5
Constriction . ..	14·5	11·5	14·5	14·0	15·0	14·5	—	13·5	12·5
Palate length . .	33·0	22·0	32·0	33·0	33·5	30·5	—	31·0	32·0
Palate breadth inside M^3	12·0	—	11·5	12·5	12·0	10·5	—	11·0	10·5
Ant. palatine foramina	5·5	3·0 ca.	3·5	6·0	3·5	2·5 ca.	—	3·5	3·0
Diastema	8 5	5·5	8·0	9·5	10·0	7·5	—	8·5	8·5
Basicranial axis	18·0	12·0 ca.	19·5	18·5	19·0	17·0	—	18·0	18·0
Basifacial axis	35·5	25·0	35·0	35·0	36·5	33·0	—	34·5	34·0
Facial index	197	208	179	188	192	194	—	191	189
$Ms^{1.3}$	13·0	—	12·5	11·5	12·5	8·5 ($Ms^{1.2}$)	—	8·5 ($Ms^{1.2}$)	8·0 ($Ms^{1.2}$)
P^3	—	3·5 ca.	—	—	—	3·5	3·0	3·5	3·0
P^4	6·0	—	5·5	5·5	5 ca.	—	—	—	—

Table III.

Skull Dimensions of *Potoröinae*, expressed as percentages of the basal length and derived from mean values of series of both ♀ and ♂ at the P^4M^4 stage.

	Aepyprymnus rufescens.	Bettongia lesueuri.	Bettongia cuniculus.	Bettongia (¹) gaimardi.	Bettongia penicillata.	Potorous tridactylus.	Potorous (¹) gilberti.	Potorous (¹) platyops.	Caloprymnus campestris.
Basal length	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0	100·0
Zygomatic breadth	69·3	71·2	65·3	68·5	61·5	60·1	55·8	70·0	74·9
Nasals length	38·0	47·0	48·6	47·2	47·1	55·2	51·4	48·0	50·7
Nasals greatest breadth	23·1	21·2	20·8	24·5	18·8	17·4	19·8	26·0	36·5
Nasals least breadth .	13·6	9·8	10·7	14·1	9·4	7·7	8·8	9·2	14·1
Nasals overhang ..	11·5	10·6	10·4	—	9·4	9·9	—	—	9·5
Depth anterior nares ...	22·4	21·2	20·5	—	21·7	19·1	—	—	24·8
Constriction	22·4	21·2	27·8	29·4	26·0	24·8	25·0	29·2	29·4
Palate length	65·3	63·6	65·3	69·2	66·6	69·7	64·7	60·0	62·7
Palate breadth inside M^3	24·4	21·2	21·2	22·3	20·2	19·8	19·1	20·0	22·8
Ant. palatine foramina	4·1	6·0	6·2	4·7	5·8	5·3	5·0	4·2	9·1
Diastema	13·6	13·6	19·0	18·8	19·5	20·2	20·6	15·6	17·0
Facial index(²)	214	181	234	225	213	264	—	—	189
$Ms^{1.3}$ MAXIMA	21·7	20·4	19·5	20·1	18·1	19·7	17·6	17·8	23·4
P^3 .... MAXIMA	9·5	6·8	7·8	—	5·8	6·9	—	—	6·6
P^4 .... MAXIMA.	12·1	12·8	12·0	10·2	10·1	9·5	8·1	9·8	11·4

(¹) One example only: From B.M. Catalogue of Marsup. and Monotrem, 1888.
(²) Unmodified.

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EXPLANATION OF PLATES.

Plate VII.

Caloprymnus campestris. General outline of subadult ♂, from a photograph taken a few seconds after death.

Plate VIII.

Fig. 1. *Caloprymnus campestris.* Profile view of the head of an adult ♀.

Fig. 2. Front view of adult ♀.

Plate IX.

Types of country in the habitat of *Caloprymnus.*

Fig. 1. The gibber plains. A view of Sturt's Stony Desert, showing glare on the gibbers in the early morning sun.

Fig. 2. A sandridge—claypan unit, near Clifton Hills Station.

CORRIGENDUM.

Vol. lv. (1931), p. 75, line 30, from top:—*For,* "and in no part of the valley was I able to examine whether their habitats overlap," *Substitute,* "and in no part of the valley I was able to examine do their habitats overlap."

PRELIMINARY DESCRIPTIONS OF TWO NEW MAMMALS FROM SOUTH AUSTRALIA.

1. *Thalacomys minor*, var. *miselius* (subsp. nov.).
2. *Pseudomys (gyomys) apodemoides* (sp. nov.).

By H. H. Finlayson,
Honorary Curator of Mammals, South Australian Museum.

[Read October 13, 1932.]

Thalacomys Minor Miselius, subsp. nov.

A small form exhibiting many of the characters of both *minor* and *leucurus* as described. Size about as in *minor*, but distinguished from the typical variety by its much paler and more castaneous general colouration, by its basal under-fur, dorsal tail stripe, and sole of pes being slate and not black, by its entirely white limbs, and by the constant presence of a rhinal callous confluent with the rhinarium. From *leucurus*, as described, it is distinguished by the less fulvous tone of its colouration and by the presence of dark areas of fur on the dorsum of tail and sole of foot.

Pelage exceedingly fine, soft and silky and in the series of summer skins available, quite without guard hairs. General colour of the dorsal surface, when viewed from a little distance, a delicate cinereus tan. In the mid-lumbar region the fur is 22 mm. long. For its basal $\frac{2}{3}$ it is a medium slate colour, merging distally into a subterminal band of very pale grey and culminating in a bright chestnut tan tip. The demarkation of the pale grey and chestnut portions from one another is vague, and their relative lengths variable, but the latter never occupies more than $\frac{1}{3}$ of the length of the shaft. When the tips are massed by compressing the fur with a comb, the terminal colour is seen to vary from Ridgway's "Hazel" to "Chestnut," but owing to the fluffy nature of the pelage the tips are much dispersed and the subterminal pale grey band greatly reduces the richness of the external colour.

The muzzle, to about the posterior level of the mysticial vibrissae, is clothed with adpressed short silvery hairs, but the rest of the dorsal surface is as described, except that the length of fur and depth of colour of the basal zone diminish both cephalad and caudad from the lumbar area.

The ventral surface is pure white externally, very pale slate basally, and in some individuals there are mid-ventral areas where the hairs are white throughout their length. The colouration of the sides is like that of the back, and merges imperceptibly with the ventrum. The rhinarium is flesh-coloured, and a rhinal callous is present in all specimens and extends back along the muzzle as much as 9 mm. All sets of facial vibrissae are well developed, the smaller members of the sets white, the larger black basally and white distally. The ear is pale flesh-coloured in the conch, but distally the pinna is prominently dappled with slate or black. Externally at the base it is clothed with the tan-tipped hairs of the head, but for its distal $\frac{4}{5}$ it is sparsely covered with short adpressed iron-grey or silvery hairs, forming at the margins a distinct though not prominent fringe. Internally it is almost naked save for a narrow area along the postero-distal margin which is clad as on the outer surface. The forelimb is white on all surfaces externally, though on the upper segment the hairs are pale slate basally. The palm of the manus is pink and naked except for a narrow tract of adpressed hairs in its centre, quite isolated from those of the carpus. The interdigital pads, however, are not

especially well developed. The upper surface of manus and digits is rather scantily clothed with white hairs. The femoral portion of the hind limb is covered with body hairs, darker and less differentiated than those of the fore limb, but the tibial segment is almost naked. The pes, which is exceedingly slender and delicate, is uniformly white above to the extremity of the digits. Below, the sole is hairy throughout except for calcaneal and interdigital pads, and varying lengths of the portion lying between these points is coloured pale slate; the rest white.

The tail is almost circular in section. Its basal $\frac{1}{8}$ is clothed above and below with body fur, the distal $\frac{3}{8}$ bears on its upper surface a beautiful crest of progressively lengthening pure white opaque hairs, and the central $\frac{3}{8}$ is short-haired on all surfaces, but in the centre line of its dorsum bears a narrow well-defined longitudinal band of pale slate hairs, bordered on either side by fawn. Unlike the dark caudal hairs of the other forms, these in *miselius* do not lengthen to form a crest and are quite confined to the centre line of the upper surface. Below, the tail is white and short-haired in its entire length.

The *skull*, both in structure and dimensions, is very close to that of *minor* as described by Spencer. [Roy. Soc. Vict., vol. ix. (new series), 1897, p. 6.]

Dimensions of Type (measured in the flesh).

Head and body, 250 mm.; tail, 155 ; pes, 74; ear,(1) 72.

Skull.—Basal length, 62·5; greatest breadth, 30·5; nasals length, 29·5; nasals greatest breadth, 5·7; constriction, 10·5; palate length, 38·8; palate breadth, inside M^2, 10; ant. palat. foramen, 6·5; basicranial axis. 19·5; basifacial axis, 43·5; facial index, 223; $M^{1\cdot3}$, 9·5.(2)

Habitat.—Eastern portion of the Lake Eyre Basin; type locality, Cooncherie, on the lower Diamantina in South Australia; lat., 26° 32′, approx.

Type of subspecies in the South Australian Museum. Registered number, M. 3465 (field number, 1218 HHF).

A series of twelve specimens, personally collected by L. Reese, Esq., and the author, and examined in the flesh, December, 1931.

A somewhat fuller description of this form has been given than is usually accorded to subspecies, partly because the material relating to *minor* which has been available for comparison is not as adequate as I would wish, and partly to emphasize its obvious relation to *Th. leucurus* Thos. I have no doubt that the latter species (the single example of which came from South Australia) was founded on a very immature and greatly faded spirit specimen of the present form. There are no features in the skull, dentition, manus, pes, and dimensions of *leucurus* which cannot be closely matched in similarly immature examples of the present series.

Thomas stated that in *leucurus* the rhinal callous was suppressed, but in the coloured plate of that animal published in the British Museum Catalogue of 1888 it appears to be distinctly indicated; in all examples of *miselius* so far examined it is present, but is variable in extent and may have less significance as a distinguishing feature than was thought. As for the differences in colouration, they are of such a kind as to be completely accounted for by the bleaching, either partial or complete, of the slate under-fur and the very pale slate areas on the dorsum of tail and sole of pes. Such bleaching is a commonplace of museum experience and in some species takes place very rapidly; in *Notomys mitchelli,* for example, the fading of the basal zone of the fur throws into greater relief the

(1) The length of ear is not comparable with that given by Spencer, owing to a different usage in determining it.

(2) The length of $M^{1\cdot3}$ quoted in Spencer's list of dimensions is 12·0 mm., but in his natural size figure of the skull these teeth have a length of 9·25 mm. in close agreement with the above.

brown tips of the fur and produces a change in general colour almost exactly like that which distinguishes *Th. leucurus* (as figured) from *Th. minor miselius.*

As regards the name to be used for the smallest of the bilbies, it would appear that *leucurus* (1887), though having priority over *minor* (1897), is inappropriate and misdescriptive, since the tail is not wholly white, and should give place to Spencer's name *minor.* Further remarks will be made on the habits and distribution of the animal in another place, meantime experiments on the synthesis of *Th. leucurus* from *Th. minor miselius* by photo-oxidation are proceeding.

Pseudomys (gyomys) apodemoides, sp. nov.

A small pale blue-grey mouse, the most southerly of the *albocinereus-glaucus* group so far taken. Closely resembling these two species in colouration but markedly distinct from its nearest geographical allies in the subgenus, *Ps. (gyomys) novae-hollandiae* (Waterhouse) and *Ps. (gyomys) desertor* (Troughton).

The following description is founded on living or freshly-killed animals. General colouration of dorsum at a little distance a light ashy blue-grey, remarkable for the coldness of its tone and the virtual absence (or great reduction) of all fulvous tint. Fur exceedingly fine, soft, and erect, recalling, in young examples, that of *Petaurus breviceps.* Mid-dorsally the bulk of the fur is 12 mm. long, but a few guard hairs reach 15 mm. The basal $\frac{3}{8}$ of the fur, a dark slate, succeeded by an ashy terminal band, the effect of which is little modified by the rather sparsely distributed guard hairs which are black tipped. The overlay of guard hairs is reduced on the muzzle and increased slightly on the rump, but, nevertheless, the general dorsal colour is very uniform. The ventral fur for its basal half a paler slate than on the dorsum; the distal half pure white and the general external colour of the belly also white, the basal slate colour not showing through. On the sides the passage from the dorsal to the ventral colouration is rather gradual, and there is no appearance of a fawn belt at the transition as in many *pseudomys* species. The lower facial and gular areas are white externally and slate basally, like the belly. The mystical vibrissae are well developed, reaching 35 mm. in length—the anterior members of the set white, the posterior black. The ear is pale and naked within the conch but becomes darkly pigmented towards the upper margin, where also it is sparsely furred a pale brownish-grey. Externally the base of the ear is clothed with the crown hairs; the margins are fairly well covered with darker grey-brown hairs than those within. Tail evenly and moderately well haired, but its substance appearing a bright delicate pink in life. The anterior part of its dorsal surface is white, variably pencilled with dark grey, the sides and lower surface pure white. The dorsum of the hands and feet is furred a pure silvery white, but the palms and soles are bright pink. In the series examined the pelage is very constant, but it may be noted that in immature animals the tail tends to be wholly white, and as age advances the dorsal overlay of black-tipped guard hairs is considerably increased.

Skull.—Somewhat variable in the series examined, age characters being marked. The fully adult skull is of very peculiar shape; long, narrow, and with excessively fragile thread like zygomata, which are distinctly concave in outline when viewed from above. The muzzle region is long in comparison with the frontal, and the nasals taper posteriorly so sharply as to make almost a point contact with the frontals. As regards the subgeneric characters laid down by Thomas, the evidence of the zygomatic plate and pterygoid fossa is inconclusive.(8)

(8) The tone of Thomas's paper on the classification of Australian murines (Ann. Mag. Nat. Hist., series 8, vol. vi., p. 603) is such as to suggest that his creation of the four subgenera of *pseudomys* was a tentative step only. No statistical evidence as to the constancy of the characters chosen was given, and in forms so numerous and closely allied it is scarcely to be expected that sharp cleavages into restricted groups will be possible.

The anterior edge of the zygomatic plate slopes gently forwards from its upper angle to its base and is straight or feebly concave in outline. Both outer and inner pterygoids are moderately well developed and enclose a very obvious fossa. These features rather suggest *Thetomys*. On the other hand, since the first upper molar has no antero-internal cingular cusp and as its laminae are not "tilted back," *Gyomys* is indicated, and the size of the animal, its general external characters and obvious relation to *glaucus* and *albocinereus*, leave no doubt that this is its natural place.

Fourteen specimens examined.

Dimensions of the Largest Male and Largest Female Measured in the Flesh.

Head and body, 80, 90; tail, 97, 92; pes, 21·0, 20·5; ear, 16, 16.

Skull of Largest Male.—Greatest length, 25·8; basilar length, 19·3; breadth of brain case, 11·5; palatilar length, 11·5; palatal foramen, 5·0; nasals, 9·0 x 2·5; interorbital width, 3·8; bullae, 4·7; upper molar series, 3·8.

Type.—Adult female in South Australian Museum, M. 3466.

Habitat.—Upper South-Eastern district of South Australia; type locality, Coombe, in lat. 35° 50′ S, and long. 140° E., approx.

From *glaucus*,(4) which the present form approaches in bulk, it is distinguished by its smaller skull and molars, shorter tail, feet, and ears, and by the belly fur being white externally and not greyish. From typical *albocinereus* it differs in its much smaller size, and from the insular *albocinereus squalorum*, to which it corresponds exactly in bodily dimensions, it is distinguished by a slightly larger skull, darker dorsal colouration, and more densely furred tail.

Its correspondence to the insular *squalorum* is very close, and the question of according it specific or subspecific distinction from *albocinereus* is a difficult one to decide. Although the habitats of the two forms (as at present ascertained) are separated by an immense tract of at least 1,500 miles, it has to be remembered that the littoral belt of the South-West, and the Southern districts and archipelagos of this State, show certain faunal likenesses which argue a continuous distribution at no very remote time. On the other hand, it is significant that the supposed identity of eastern and western rodent forms has seldom stood the acid test of a critical examination of adequate series of both. On the whole, it appears better to accord the new form the same degree of separation from *albocinereus* as *glaucus*; at least until specimens are obtained from intermediate localities.

For the whole series examined, I am greatly indebted to Mr. W. J. Harvey, whose keen interest and promptness has enabled me to keep the living animal under observation and has supplied some details of its occurrence and habits. These and allied matters will be dealt with elsewhere.

(4) *Glaucus* was said by Thomas to be the largest species of the subgenus, but the dimensions quoted [Ann. Mag. Nat. Hist., series 8, vol. vi., (1910), p. 608] are uniformly smaller than those of *albocinereus* taken by Shortridge in the Avon District in 1906 (P.Z.S., 1906, vol. ii., 776).

A SIMPLE APPARATUS FOR DEGREASING BONES FOR MUSEUM PURPOSES.

By H. H. Finlayson,
Honorary Curator of Mammals, South Australian Museum.

[Read October 13, 1932.]

The general practice of preparing mammal skulls and skeletons by maceration, followed by liming, frequently leaves a good deal to be desired in the condition of the final product. Unless the time of maceration is so prolonged that there is risk of loss of teeth and disarticulation of joints, a large proportion of the original fat remains within the bone, and it is a common experience that preparations which leave the taxidermist quite immaculate develop, after one or two Australian summers, unsightly patches of grease by the slow diffusion outwards of the unaltered fat. The fat, moreover, retains very persistently some of the malodorous products of the initial putrefaction, and it also rapidly becomes rancid through oxidation at the surface. Preparation by boiling is not of much service in the cleaning of skeletons, and although an excellent method for skulls (having the great advantage of speed), leaves the bone still more greasy than after maceration.

In the past, a scrupulous cleanliness has scarcely been a leading trait in some departments of Museum work, and there are many hardy spirits amongst the older generation who are not to be deterred by such a trifle as unsavouriness of material. A feebler generation, however, may well prefer to work under conditions of olfactory peace, and both schools may appreciate the diminished chances of insect infection and the distinctness of sutural condition which follows as a result of freedom from fat.

The technology of bone degreasing has a considerable literature, and the application of the process to Museum work has, of course, not been overlooked. Two methods are in vogue. Degreasing by immersion, while of value for small objects is slow, and with even moderate-sized skeletons requires a relatively very large volume of solvent, and frequent distillations of the same, to remove dissolved fat. Degreasing by boiling with a small quantity of the solvent in such a way that escape of the vapour is prevented by condensation is a much sounder principle economically, and several extractors for Museum purposes based upon it have already been described. (See, for example, Rowley, "Taxidermy.")

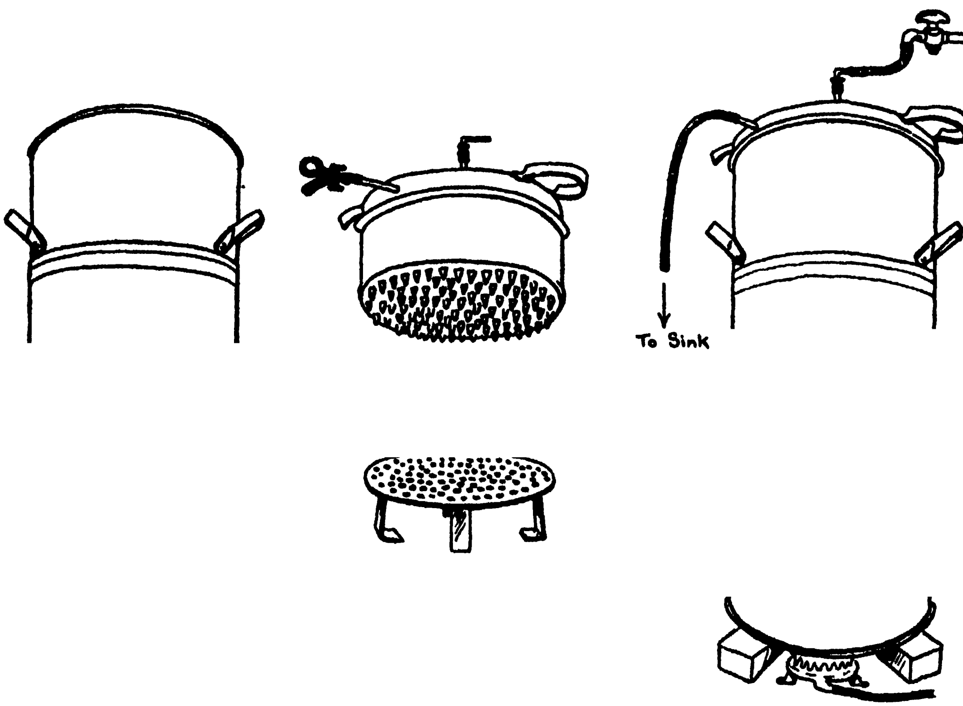
Some of these, however, are rather over-elaborate for small scale purposes, and others are apparently not at all rapid and they may usefully be supplemented by the apparatus here described, which is free from both these faults.

The extractor (see figure), which in principle is virtually that described by T. Brailsford Robertson and L. A. Ray,[1] consists of three parts each made of a stout sheet-iron heavily tinned. Firstly, a cylindrical container 3′ deep and 16″ wide, open at the top, closed at the bottom, and provided with stout rivetted handles and reinforced at the rim in the usual way by turning back the metal over a circlet of wire. The bottom is preferably of somewhat heavier metal than the sides and, whatever method is used in fitting it, great care is taken that a water-tight and gas-tight join is made. Secondly, a false bottom, clearing the sides of the cylinder by not more than ⅛″ and perforated with ⅛″ holes at ½″ intervals. When in place it is raised about 4″ from the true bottom by four stout legs. Thirdly, the condenser; this takes the form of a vessel closed except for outlet

(1) Rept. of Austr. Ass. Adv. Science (1924), p. 264.

and inlet tubes, for cooling water. It is of about the same diameter as the false bottom and is 6″ deep. At about 1″ from the top it is provided with a stout flange projecting $\frac{3}{4}''$ from the wall, and when in position this simply rests on the rim of the container, and it is neither necessary nor desirable to gasket the area of contact. The water tubes are of brass or copper. The inlet tube pierces the centre of the top of the condenser and reaches to within $\frac{1}{2}''$ of the bottom; the outlet tube is soldered into the side as near the top as possible. The bottom of the condenser is studded with blunt spikes about $\frac{1}{2}''$ long—conveniently by soldering broad-headed carpet tacks over its surface at $\frac{1}{2}''$ intervals.

The procedure is as follows:—The container is supported by standing it upon bricks on a cement or other fire-proof floor, and some care is taken to see that it is quite vertical. Half to three-quarters of a gallon of solvent is then poured in, the false bottom inserted, and the bones (which must be quite dry) are stacked



upon it quite loosely; if skulls are included, care should be taken that the smaller and more fragile are towards the top of the pile, since (in a large batch) the pressure on the lower layers is considerable. The condenser is then put in place, and after connecting the inlet by rubber tubing to a tap, and the outlet to a sink, the water is turned on and the tap adjusted so that a rapid stream issues from the outlet. It is important that there should be no failure in the water supply. A ring gas-burner or electric hot-plate is then placed under the extractor and the rate of heating adjusted so that the solvent boils sufficiently vigorously to throw a rapid current of vapour into contact with the cold condenser. The upper limit of the column of vapour can be roughly ascertained by feeling the temperature of the sides of the container; if benzine or carbon tetrachloride is used the metal should be uncomfortably hot, at a point an inch or so below the bottom of the condenser. Condensation on the cold metal surfaces is so efficient that it is almost impossible with ordinary heating to force vapour from the top of the extractor.

but considerations of economy in fuel operate in determining the best rate of heating.

For the benefit of the non-technical reader it may be explained that the degreasing process which goes on in the extractor depends upon the fact that the material is maintained in an atmosphere of hot vapour and is continually bathed in fresh solvent, falling as a shower from the studs on the bottom of the condenser. On the surface of the bone, a solution of fat in the solvent is constantly forming, which drains away into the space below the perforated false bottom. There, the fat, being non-volatile, accumulates out of contact with the bones, while the volatile solvent is driven back by the heating, through the diaphragm into contact with the condenser again. From this sketch of the rationale of the process it will readily be understood that a relatively small volume of liquid will suffice for the treatment of a large quantity of bones.

With regard to the time taken to complete the degreasing, it is not possible to lay down any hard and fast rule. Much depends on the nature of the bones, a dense macropod tibia,[2] for example, taking much longer than a porous cancellated bird skeleton, but in all cases complete dryness of the material greatly facilitates the removal of the fat and prevents an objectionable softening and distortion of cartilage, which may otherwise occur. If possible, the material should be given a preliminary drying in an air-oven at a temperature of about 50° C. The writer is accustomed to give all material a 12-hours treatment, and very few bones show any greasiness at the end of such a time. It should be remembered that when heating is first discontinued the bones are saturated with liquid solvent, and to minimise loss they should be allowed an hour or so in which to drain before opening the apparatus. The material is then removed and spread out in the open for a day or so until the last trace of solvent has evaporated. The solvents available for the work are many, but the most suitable are perhaps, ether, benzene, light petrol, and carbon tetrachloride. Of these, ether is undoubtedly the most effective. but its low boiling point (35° C.) and great inflammability of the vapour introduce a considerable element of risk into its use by those unaccustomed to laboratory practice. To a lesser degree this applies also to benzene (80° C.) and light petrol (50°–100° C.), but in all three cases the risk of fire may be reduced by the use of electric hot plates for boiling. Probably, however, the best liquid for ordinary purposes is carbon tetrachloride. It has a boiling point of 77°, is non-inflammable, an excellent fat solvent, and is comparatively cheap even in Australia; moreover, it has the further advantage that it is already extensively used in Museums as a fumigant. The only disadvantage attending its use, is that with material which is not thoroughly dry it tends to develop a slight acidity by hydrolysis, which sets up corrosion in the apparatus. Although not strictly necessary, it is preferable to remove the fat solution from the apparatus after each extraction and to begin the next with clean solvent. The latter, of course, can easily be recovered from the accumulated fat solutions, by distillation.

(2) These are best treated by drilling the epiphyses.

NEW AUSTRALIAN LEPIDOPTERA.

By A. JEFFERIS TURNER, M.D., F.E.S.

[Read August 11, 1932.]

These descriptions of 16 new genera and 54 new species are of 18 families. Of them 7 genera and 23 species belong to the *Noctuidae*. Owing to the unfortunate suppression of the last three volumes of Sir Geo. Hampson's great revision, work on the *Quadifidae* section of this family is difficult for those who cannot refer to the collection in the British Museum. I wish to acknowledge the valuable help I have received in many instances from Miss A. E. Prout, more especially in the *Hypeninae*. It is to be hoped that this able and accurate worker may be enabled to continue her observations on the *Noctuidae*.

From Mr. T. G. Campbell, of the staff of the Council of Scientific and Industrial Research, I have received a most interesting collection from North and North-West Australia, and I have to thank him, and others, for much interesting material.

Family LARENTIADAE.

Scotocyma ischnophrica, n. sp.

ισχνοφρικος, slenderly rippled.

♀, 30 mm. Head, palpi, antennae, thorax, abdomen, and legs dark fuscous. Forewings broadly triangular, costa arched at base, thence straight to near apex, apex rounded, termen rounded, moderately oblique; ochreous-whitish with numerous fine wavy transverse lines and irroration fuscous; a basal patch extending from midcosta to ⅔ dorsum, in which these lines are darker and closer, and dilated and confluent near margins; a fuscous costal streak from base to ⅓; a large costal spot before ⅔, and dorsum interruptedly to ⅔, fuscous; median area paler with very slender rippled lines, its outer edge from ¾ costa to ⅘ dorsum, with a large obtuse median projection; terminal area fuscous, veins dotted with whitish; a subterminal series of whitish dots between veins; a small whitish suffusion on midtermen; cilia fuscous. Hindwings with termen rounded, dentate; fuscous with whitish dots on veins; cilia fuscous.

Queensland: Mount Tambourine, in February; one specimen received from Mr. E. J. Dumigan.

Family STERRHIDAE.

Eois eucrossa, n. sp.

εὐκροσσος, well bordered.

♀, 26 mm. Head whitish; fillet and face dark fuscous. Palpi 1; fuscous. Antennae whitish; base anteriorly fuscous. Thorax and abdomen whitish with scanty grey irroration. Legs whitish with scanty fuscous irroration. Forewings broadly triangular, costa straight to ¾, thence arched, apex rounded-rectangular, termen slightly rounded, moderately oblique, finely crenulate; whitish with scanty but uniform grey irroration becoming fuscous towards base; a grey discal dot beneath ⅔ costa; three slender faint crenulate transverse lines, first sinuate from ⅔ costa to ⅔ dorsum, second and third approximated, curved, subterminal; terminal edge faintly purple-tinged; cilia whitish with a dark fuscous basal line. Hindwings with termen strongly rounded; colour and cilia as forewings.

The curious margins of the wings are distinctive.

North Australia: Katherine in July; one specimen received from Mr. T. G. Campbell. Type in Museum of Economic Entomology, Canberra.

Family OENOCHROMIDAE.

Dinophalus axia, n. sp.

ἄξιος, worthy.

♂, 24-28 mm. Head with cone-shaped prominence ending in a single sharp hook directed downwards; dark fuscous. Palpi 1; dark fuscous. Antennae fuscous; pectinations in male 6. Thorax dark fuscous. Abdomen white with a few fuscous scales. Legs fuscous with whitish rings; posterior pair whitish. Forewings triangular, costa straight, apex pointed, termen rounded, slightly waved, slightly oblique; dark fuscous; an oblique median fascia whitish-grey with a few fuscous scales; a blackish crenulate antemedian line from $\frac{1}{3}$ costa to $\frac{1}{4}$ dorsum within median fascia near its anterior edge; a finely dentate line from $\frac{3}{4}$ costa to $\frac{2}{3}$ dorsum, sometimes preceded by fuscous-brown, sometimes posteriorly white-edged; an ill-defined terminal grey fascia; a blackish terminal line; cilia grey. Hindwings with termen rounded; white; a more or less distinct grey terminal band, sometimes traversed by a darker dentate transverse line; cilia whitish, towards tornus grey.

North-West Australia: Wyndham, in December and February; two specimens received from Mr. T. G. Campbell. Type in Museum of Economic Entomology, Canberra.

Gen. **Anomogenes**, nov.

ἀνομογενης, alien.

Tongue absent. Face not projecting. Palpi moderate, porrect, thickened with loose hairs; terminal joint concealed. Antennae bipectinate to apex in both sexes. Thorax and abdomen stout. Thorax densely hairy above and beneath; with a rounded posterior crest. Femora hairy. Posterior tibiae without middle spurs. Tarsi not spinulose. Forewings without areole; 2 from $\frac{3}{4}$, 3 from before angle, 4 from angle, 5 from near upper angle, 6 from angle, 7, 8, 9, 10 stalked, 11 anastomosing with 12 and 10. Hindwings with cell long ($\frac{2}{3}$); 2 from $\frac{2}{3}$, 3 and 4 separate, 5 from upper angle of cell, connate with 6, 7, which are stalked, 12 approximated to cell to beyond its middle.

A genus of peculiar and specialized structure. In the neuration of the forewings it approaches *Cernia*, in that of the hindwings *Sarcinodes*, but in neither instance is there any close relationship.

Anomogenes morphnopa, n. sp.

μορφνωπος, dark.

♂, 26 mm.; ♀, 34 mm. Head and thorax fuscous. Palpi 2; fuscous. Antennae fuscous; pectinations in male 5, in female 3. Abdomen grey with darker rings. Legs fuscous. Forewings triangular, costa in male straight, in female gently arched, apex rounded, termen strongly rounded, oblique; fuscous; markings and many small strigulae dark fuscous; a sub-basal line not reaching dorsum; a fine line from $\frac{1}{6}$ costa to $\frac{1}{4}$ dorsum, outwardly curved, indented above middle; a small slender transverse discal mark at $\frac{1}{3}$; a well-marked, finely dentate, slightly sinuate line from $\frac{5}{6}$ costa to $\frac{3}{4}$ dorsum; cilia fuscous. Hindwings with termen rounded; whitish peppered with fuscous dots; a discal median spot, a transverse line at $\frac{2}{3}$, and an oval apical blotch, fuscous; some terminal dots; cilia whitish.

Queensland: Roma; two specimens bred from larvae feeding on the finger-lime, *Citrus australasica*, received from the Queensland Department of Agriculture. The types will be deposited in the Queensland Museum.

Family EPIPLEMIDAE.

Epiplema amydropa, n. sp.

ἀμυδρωπος, dark.

♂, ♀, 24-30 mm. Head and thorax grey; face and palpi dark fuscous. Antennae grey; pectinations in male 2. Abdomen grey; tuft in male whitish. Legs grey; internal surface of second joint fuscous. Forewings triangular, costa slightly arched, apex pointed, termen rounded, more or less sinuate beneath apex, slightly oblique; grey, sometimes brownish-tinged, with sparsely scattered fuscous irroration or minute strigulae; strigulae better developed near termen; cilia grey. Hindwings angled on vein 4, and in female slightly produced, also angled on vein 7; as forewings.

Queensland: Toowoomba, in November, December, and March (W. B. Barnard and E. J. Dumigan); four specimens.

Family NOCTUIDAE.

Canthylidia capnoneura, n. sp.

καπνονευρος, dark-nerved.

♂, ♀, 40-46 mm. Head and thorax brownish-grey. Palpi 1¼; whitish, towards apex grey. .Antennae grey; in male minutely ciliated. Abdomen grey; base of dorsum reddish-brown. Legs grey tinged with reddish-brown; posterior pair grey-whitish. Forewings elongate-triangular, costa very slightly arched, apex rounded-rectangular, termen scarcely oblique, rounded beneath; pale grey with more or less brown suffusion; all veins dark fuscous; a white median streak running through cell and between veins 5 and 6 to termen; termen whitish between veins; cilia grey or whitish-grey. Hindwings with termen sinuate; dark grey; paler towards base; cilia white.

Queensland: Bunya Mountains, in November; six specimens received from Mr. W. B. Barnard, who has the type.

Eustrotia eremotropha, n. sp.

ἐρημοτροφος, desert-bred.

♀, 23-30 mm. Head and thorax whitish-grey. Palpi 1½; whitish, sprinkled with fuscous. Antennae grey annulated with blackish. Abdomen grey-whitish. Legs whitish with fuscous rings and irroration. Forewings triangular, costa straight to near apex, apex rounded-rectangular, termen slightly rounded, scarcely oblique; whitish partly suffused with grey and sprinkled with fuscous; four indistinct fuscous transverse lines; first from ¼ costa to ⅔ dorsum, irregular bent outwards above dorsum; second and third indistinct, between them a large pale oval reniform; fourth sinuate, sometimes double, from ⅔ costa to ⅔ dorsum; a fuscous subterminal shede, sharply outlined posteriorly, with projections above middle, below middle, and on dorsum; a terminal series of dark fuscous dots; cilia grey mixed with whitish. Hindwings with termen rounded; grey; cilia as forewings.

Near *E. macrosema* Low, but paler and the reniform much smaller.

Central Australia: Newcastle Waters,, in June four specimens received from Mr. T. G. Campbell. Type in Museum of Economic Entomology, Canberra.

Lophoptera acrogramma, n. sp.

ἀκρογραμμος, with apical inscription.

♂, 35 mm. Head fuscous; centre of face white. Palpi 3; fuscous, extreme apex whitish. Antennae dark fuscous. Thorax fuscous with a broad central white streak. Abdomen fuscous; the thoracic streak is continued nearly to middle;

and contains a brown spot; tuft whitish. Legs dark fuscous; tibiae and tarsi with very slender whitish rings. Forewings narrow, triangular, costa straight, gently arched towards apex, apex rounded, termen strongly oblique, dentate; fuscous; obscurely darker, very slender, rippled, transverse lines in basal half; reniform indicated by two whitish marks, anterior very slender, transverse, edged with brown, posterior larger, oblique, edged with dark fuscous; a quadrate blackish spot beneath 4/5 costa; from this a strongly bisinuate blackish line, edged with brown, to 2/3 dorsum; following this closely a very slender, dentate whitish line nearly to tornus, posteriorly edged with brown; a short whitish streak from apex, acutely angled beneath costa, ending acutely before termen; beneath this a small whitish and brown suffusion; brown streaks on veins in terminal area; a blackish terminal line interrupted by minute whitish dots on veins; cilia fuscous. Hindwings ample, termen rounded, wavy; dark fuscous; central area to 2/3 scaleless except on veins, hyaline, violet-tinged; cilia fuscous, bases and apices whitish.

North Queensland: Mackay, in April; one specimen taken by Mr. A. N. Burns. Type in Coll. Lyell.

Lyncestis phaeocrossa, n. sp.

φαιοκροσσος, dark-edged.

♂, 34-36 mm. Head ochreous-grey-whitish; face fuscous. Palpi 1¼; closely appressed to face; whitish. Antennae grey; ciliations in male minute. Thorax ochreous-grey-whitish; posterior crest fuscous. Abdomen ochreous-grey-whitish. Legs ochreous-grey-whitish with fuscous tarsal rings. Forewings elongate, narrow, costa straight, apex rounded, termen crenulate, obliquely rounded; ochreous-grey-whitish; markings fuscous; a costal suffusion, which forms a broad streak beyond 2/3; a broad dorsal streak from near base to tornus; reniform represented by an oblong longitudinal spot at 3/5; a fine median streak beyond cell, another on lower edge of cell; a small supratornal blotch continuous with dorsal streak; cilia concolorous. Hindwings with termen rounded; white; a broad blackish terminal band from costa to vein 2; cilia white with two fuscous bars below middle.

North-West Australia: Wyndham, in December; two specimens received from Mr. T. G. Campbell. Type in Museum of Economic Entomology, Canberra.

Crypsiprora cyclospila, n. sp.

κυκλοσπιλος, with circular spot.

♀, 30 mm. Head brown-whitish; upper half of face fuscous. (Palpi missing.) Antennae grey. Thorax grey-brown; posterior crest fuscous. Abdomen ochreous-whitish densely sprinkled with fuscous; basal crest strong, fuscous. Legs fuscous with ochreous-whitish rings; posterior pair mostly ochreous-whitish. Forewings elongate-triangular, costa straight to 3/4, thence slightly arched, apex rectangular, termen rounded, scarcely oblique; ochreous-whitish suffused with fuscous-brown; antemedian line at 1/3 incomplete, reduced to several blackish dots; postmedian very slender, fuscous, from beneath 5/6 costa, at first transverse, then with a strong posterior tooth and inwardly oblique to beneath reniform, then angled and transverse to 2/3 dorsum; reniform approximately circular, edged fuscous with brownish centre, preceded by an oval oblique whitish spot; a dark fuscous interrupted subterminal line wtih a slight flat-topped projection beneath costa and another more prominent below middle, preceded by a narrow brown fascia; four ochreous-whitish dots on apical third of costa; a pale interrupted submarginal line; cilia fuscous. Hindwings with termen rounded; grey; cilia grey, apices grey-whitish.

Crypsiprora Meyr. has a strong crest on basal segment only of abdomen, only in *C. niphobleta* is there a small rudiment of a crest on the third segment.

Crioa Wlk. has well-marked crests on the distal segments. I now refer *acronyctina* Butl., *nycterina* Turn., and *niphobleta* Turn. to the former genus. To *Crioa* I now refer *hyperdasys* Turn., *acronyctioides* Wlk., *hypochaetes* Turn., and *emmelopis* Turn.

North Queensland: Ravenshoe (Evelyn Scrub), near Herberton, in February; one specimen received from Mr. F. P. Dodd.

Gen. **Pherechoa,** nov.

φερεχοος, carrying a mound.

Face flat, not projecting. Tongue strong. Palpi slender, appressed to face, reaching vertex; second joint long, slightly rough; terminal joint moderate. Thorax with a large dense rounded posterior crest; underside smooth. Abdomen not crested. Legs not hairy. Forewings with neuration normal. Hindwings with cell less than ½; 5 well developed, approximated to 4 at origin.

Probably of the *Prorocopis* group.

Pherechoa crypsichlora, n. sp.

κρυψιχλορος, with hidden green.

♀, 26 mm. Head pale grey. Palpi whitish sprinkled with fuscous. Antennae grey. Thorax pale grey; crest fuscous. Abdomen grey. Legs ochreous-whitish; anterior pair sprinkled with fuscous Forewings triangular, costa gently arched, apex rectangular, termen slightly rounded, scarcely oblique; whitish generally suffused with greenish-grey and some fuscous scales; markings dark fuscous; costal dots near base and at ⅛, giving rise to incomplete interrupted transverse lines; a quadrate median costal spot with some fuscous suffusion beneath it; postmedian line slender distinct slightly dentate, from ¾ costa transverse to below middle, there curved inwards and again transverse to ⅓ dorsum; a subterminal fuscous shade well defined posteriorly, where it forms numerous long acute teeth; an interrupted terminal line; (cilia denuded). Hindwings with termen rounded; pale grey.

The type is in poor condition, but the generic character should secure recognition.

North Queensland: Kuranda, in June; one specimen received from Mr. F. P. Dodd.

Gen. **Ammophanes,** nov.

ἀμμοφανης, sand-coloured.

Face with strong rounded prominence, a small circular depression at its apex. Palpi smooth, slender, ascending, exceeding vertex; second joint long, scarcely thickened; terminal joint long, obtuse. Antennae in male shortly ciliated, a pair of short fine bristles on each segment. Femora somewhat hairy. Posterior tibiae with long hairs on dorsum; in male without middle spurs, inner terminal spur much thickened, outer very short. Forewings broad; neuration normal. Hindwings with cell about ½; 5 well developed, approximated to 4 at origin.

Ammophanes deserticola, n. sp.

deserticolus, inhabiting the desert.

♂, 25 mm. Head and thorax ochreous-whitish sprinkled with blackish. Palpi ochreous-whitish; basal half of external surface of second joint and some scattered scales dark fuscous. Antennae grey; ciliations in male ½, bristles 1. Abdomen grey-whitish; bases of segments sprinkled with dark fuscous; a red spot on base of dorsum. Legs ochreous-whitish with blackish rings; posterior pair ochreous-whitish. Forewings broadly triangular, costa straight to near apex,

apex rectangular, termen nearly straight, slightly oblique, ochreous-whitish suffused with reddish especially on veins and sprinkled with dark fuscous; markings dark fuscous; a series of costal dots, some of which form short strigulae; ill-defined suffused spots in disc near base, on mid-dorsum, beneath mid-costa, and beneath ⅔ costa; antemedian line from ⅓ costa to ⅓ dorsum, slender, wavy interrupted in middle; a fine wavy outwardly oblique line from subcostal spot to ¾ dorsum; postmedian from ¾ costa, slender, dentate, outwardly oblique to below middle there angled to dorsum before tornus; a terminal series of dots; cilia concolorous. Hindwings with termen rounded, dentate; whitish; a fuscous terminal band; cilia whitish with indistinct fuscous bars.

Queensland: Charleville, in December; one specimen.

Rhapsa eretmophora, n. sp.

ἐρετμοφορος, carrying paddles.

♀, 36 mm. Head and thorax fuscous-brown. Palpi moderately long, porrect, laterally compressed, paddle-shaped; second joint with apex expanded and bearing a strong tuft of scales on upper side; terminal joint expanded by scales above and beneath, obtuse; fuscous. Antennae fuscous. Abdomen grey. Legs grey; anterior pair fuscous; apices of posterior tibiae whitish. Forewings triangular, costa arched near base, thence straight, apex rectangular, termen rounded, sinuate; fuscous-brown; a suffused darker transverse line near base; orbicular at ¼, a white dot edged fuscous; reniform at middle, oval, oblique, reddish-brown with some whitish scales, edged fuscous; costal edge whitish from ½ to apex; a fine fuscous deeply crenulate line from ¾ costa to ⅔ dorsum; a subterminal series of whitish dots; a submarginal series of fuscous dots; cilia concolorous. Hindwings with termen rounded; pale grey; a fine dentate grey subterminal line; cilia pale grey.

Near *R. suscitalis* Wlk. The palpi are shorter, much broader, and differently shaped; the forewings broader, markings more definite, and costa whitish.

Queensland: Montville (1,500 ft.), near Nambour, in September; one specimen.

Gen. Lophozancla, nov.

λοφοζανκλος, with crested sickles.

Eyes smooth. Face flat, not projecting. Tongue strongly developed. Palpi long, ascending, appressed to face, exceeding vertex; second joint long, thickened with appressed scales, with a dense tuft of expansile hairs at apex posteriorly; terminal joint as thick as second, but much shorter, obtuse. Antennae in male moderately ciliated, with a single bristle on each segment. Thorax and abdomen without crests. Forewings with neuration normal, 10 arising separately from areole. Hindwings with cell about ⅓, 5 well developed from ⅓ above lower angle, parallel to 4, 6 and 7 connate, 12 anastomosing with cell at a point at ⅓.

This genus is based mainly on the peculiar palpi.

Lophozancla prolixa, n. sp.

prolixus, broadly extended.

♂, 40-42 mm. Head, palpi, thorax, and abdomen grey-brown slightly sprinkled with fuscous. Antennae grey; ciliations in male 1, bristles 1½. Legs grey-brown sprinkled with fuscous; anterior pair mostly fuscous. Forewings triangular, costa straight to near apex, apex rounded, termen slightly rounded, scarcely oblique; grey-brown with general fuscous irroration and markings; a short line from costa near base; a line from ¼ costa to ⅓ dorsum, with a median obtuse posterior projection; an incomplete outwardly curved median line; postmedian from ⅔ costa to ⅔ dorsum, swollen on costa, as are other lines to a less

degree, strongly outwardly curved and sharply dentate in disc, then bent inwards and still dentate; a pale crenulate subterminal line, indistinct towards costa; a fine interrupted terminal line; cilia ochreous-whitish with some fuscous bars. Hindwings with colour, terminal line and cilia as forewings; broadly suffused antemedian, median, postmedian, and subterminal lines, the first two not reaching costa.

North Australia: Darwin and Stapleton; two specimens received from Mr. G. F. Hill.

Catephia compsotrephes, n. sp.

κομψοπρεπης, dainty-seeming.

♂, 46 mm. Head and thorax blackish with a few white points. Palpi 1½; blackish. Antennae fuscous; in male with tufts of short cilia (¾). Abdomen dark fuscous. Legs fuscous; tarsi with fine white rings. Forewings elongate-triangular, costa straight to near apex, apex rounded, termen obliquely rounded; dark fuscous with a few bluish-white scales; an obscurely darker transverse line at ⅙; two obscure dark spots in middle arranged transversely; a blackish line from ⅗ costa obliquely outwards, describing a rounded curve in disc, thence sinuate inwards to ¾ dorsum; a terminal brownish fascia sometimes distinct, its anterior edge sharply defined with projections above and below middle, but all these may be obscure; some bluish-white scales on veins before termen; cilia blackish, bases paler. Hindwings with termen rounded; white; a broad fuscous terminal band containing three elongate white spots on veins 2, 3, and 4; a white streak on apex; cilia fuscous, on apex white.

Near *C. linteola* Gn., but the forewings smaller, darker, and with terminal fascia, hindwings white from base to beyond middle.

North-West Australia: Wyndham, in December and May; two specimens received from Mr. T. G. Campbell. Type in Museum of Economic Entomology, Canberra.

Eudesmeola inscripta, n. sp.

inscriptus, inscribed.

♂, ♀, 32-40 mm. Head and thorax fuscous-brown. Palpi 1¼; brown mixed with dark fuscous. Antennae brownish becoming dark fuscous towards base; ciliations in male ½. Abdomen grey-brown sprinkled with fuscous. Legs brownish mixed with fuscous; tarsi fuscous with whitish-ochreous rings; posterior pair mostly whitish-ochreous. Forewings triangular, costa straight to near apex, apex round-pointed, termen slightly rounded, slightly oblique, crenulate; brown suffused and irrorated with fuscous; markings blackish; a sub-basal costal spot giving origin to a short line; a curved dentate line from ¼ costa to near base of dorsum; a spot on ⅜ costa, from which proceeds a line outwards beneath costa, then sharply angled to become transverse and dentate, sharply bent inwards below middle, thence again transverse and dentate to mid-dorsum; orbicular dot-like or absent; reniform narrow, pale centred, above lower angle of postmedian line; a fine pale crenulate subterminal line; an interrupted terminal line; cilia brown. Hindwings with termen rounded, crenulate; as forewings but without antemedian line; postmedian slightly dentate, transverse.

North Australia: Katherine, in July. North-West Australia: Derby, in August; Wyndham, in November and January. Six specimens received from Mr. T. G. Campbell. Type in Museum of Economic Entomology Canberra.

Ericeia plaesiodes, n. sp.

πλαισιωδης, oblong.

♂, 44 mm. Head, thorax, and abdomen brownish-fuscous. Palpi 2; fuscous. Antennae fuscous; in male with very short tufts of cilia (½). Legs very densely hairy; fuscous. Forewings narrowly triangular, costa straight to ⅔, thence

strongly arched, apex pointed, termen slightly sinuate, oblique; fuscous-brown; several slightly darker transverse bands; of these the subterminal is most distinct, brownish-tinged, angled outwards in middle, inwards above and below, closely followed by a parallel line; a fuscous terminal line, preceded by a submarginal series of fuscous dots; cilia grey. Hindwings quadrate, twice as broad as forewings, termen obliquely angled in middle; as forewings, but subterminal line not angled.

Similar in colour to *E. sobria* Wlk., but with very differently shaped wings. Both species, together with *E. setosipes* B-Bak., have 8, 9, 10 stalked from areole.

North Queensland: Kuranda, in April; one specimen received from Mr. F. P. Dodd. Queensland: Brisbane; one specimen in British Museum.

Gen. **Clytomorpha**, nov.

κλυτδμορφος, of noble form.

Tongue strong. Palpi long, recurved, reaching vertex; second joint very long, thickened with appressed scales, but shortly rough-haired towards apex posteriorly; terminal joint short, obtuse. Antennae ¾; in male minutely ciliated, with a pair of very fine short bristles on each segment. Thorax and abdomen not crested. Tibiae without spines; inner spurs very long. Forewings with areole small, 8, 9, 10 stalked from areole, 7 connate, 11 free. Hindwings with cell very short (⅓); 5 strongly developed, closely approximated at origin to 4.

Clytomorpha psilozona, n. sp.

ψιλοζωνος, bare-banded.

♂, 64 mm. Head reddish-brown; face fuscous. Palpi fuscous, posterior aspect of apex of second joint and all terminal joints grey-whitish. Antennae pale ochreous-grey. Thorax reddish-brown with a large anterior fuscous spot. Abdomen grey; dorsum of first two segments reddish-brown. Legs fuscous; in male with an expansile tuft of ochreous hairs from base of middle femora, and long ochreous hairs on posterior surface of middle tibiae. Forewings very long, narrow, costa nearly straight but slightly sinuate, apex rectangular, termen twice as long as dorsum, strongly curved, slightly waved; reddish-brown with sparse fuscous strigulae, basal third paler; indistinct interrupted transverse lines near base and at ⅓, between them a fuscous spot; orbicular beneath costa at ⅓, circular, fuscous with pale centre; reniform a slender fuscous ring beneath midcosta, with a fuscous spot immediately below, and a pale spot posterior to that; a fuscous wavy line from costa before apex, nearly straight to middle, thence curved inwards, and sinuate to dorsum before tornus; this is preceded by fuscous suffusion beneath costa and on dorsum; cilia fuscous. Hindwings broadly dilated, termen scarcely rounded; reddish-brown, suffused with grey at apex; strigulae and transverse lines from ⅓ and ⅔ dorsum fuscous; a space bare of scales occupies central and costal part extending over half area of wing, its inner edge straight and sharply defined, posterior rounded; cilia fuscous. Underside of forewings fuscous; in male with basal ⅔ of costa bent over and fringed with long hairs; a ridge of ochreous hairs on lower edge of cell, and another in an area bare of scales beyond and below cell; of hindwings fuscous; in male with long hairs in base of costa. Male also with a pair of strong fan-shaped tufts of ochreous hairs on underside of mesothorax.

North Queensland: Kuranda; one specimen received from Mr. A. P. Dodd.

Gen. **Lampadephora**, nov.

λαμπαδηφορος, carrying lights.

Tongue strong. Face flat, not projecting. Palpi very long, ascending, laterally compressed; second joint much exceeding vertex, with a posterior apical

tuft; terminal joint as long as second, much dilated with scales anteroposteriorly, more so towards apex, but these suddenly cease, leaving apex slender, acute. Antennae in male minutely ciliated, with a pair of fine short bristles on each segment. Thorax with a posterior crest. Abdomen with crests on first and second segments. Legs smooth except middle tibiae, which are rough-scaled. Forewings without areole; 2 from ⅘, 3 from before angle, 7 free from upper angle of cell, 8, 9, 10 stalked from before angle. Hindwings with 2 from near angle, 3 and 4 stalked, 5 curved near base and approximated to 4 at origin, 6 and 7 connate, 12 anastomosing with cell to about ½.

Lampadephora panimera, n. sp.

πανιμερος, charming.

♂, ♀, 22-24 mm. Head with a large shining white spot on crown, encircled except anteriorly by a brown line, sides pale ochreous; face brown. Palpi brown. Antennae pale brown. Thorax brown with ten white spots, four on anterior margin, two before middle, two lateral and posterior, and two on tegulae; tegulae also with a submarginal white line. Abdomen pale ochreous; crests brown. Legs ochreous-whitish. Forewings triangular, costa gently arched, apex rectangular, termen slightly angled on vein 5; fuscous with some variable brown dots or suffusion; a shining white basal spot; basal area limited by a line from ⅓ costa to ⅓ dorsum, contains two sub-basal and three posterior shining white spots, intermediate space occupied by whitish-ochreous spots, the whole intersected by a fine brown network; five ochreous costal spots, first at ⅖, four confluent on apical third; an apical cluster of three shiny white and two pale ochreous spots; a smaller cluster of similar dots on midtermen; cilia yellow with an incomplete brown bar at angle. Hindwings angled on vein 2; yellow, paler towards base; a small brown suffusion on angle; cilia yellow.

The very striking and peculiar colouration is remarkably similar to that of *Dudgeona actinias* Turn., one of the *Cossidae*.

North Queensland: Cape York, in April and June; three specimens received from Mr. W. B. Barnard, who has the type.

Gen. Bathystolma, nov.

βαθυστολμος, fully robed.

Face flat with anterior tuft of scales. Tongue strong. Palpi very long, ascending, recurved, appressed to face; second joint very long, exceeding vertex, somewhat rough in front; terminal joint ½, tolerably pointed. Antennae in male simple, minutely ciliated. Thorax with a small posterior crest. Abdomen with crests on third, fourth, and fifth segments. Legs smooth with long tibial spurs. Forewings with neuration normal. Hindwings with cell short (⅓); 5 well developed, from below middle of cell (⅓).

Allied to *Artigisa* Wlk., differing in the thoracic and abdominal crests and in details of structure of palpi and antennae.

Bathystolma, brunnea, n. sp.

brunneus, brown.

♂, ♀, 28 mm. Head reddish-brown. Palpi pale brown. Thorax brown or brown-whitish; anterior edge fuscous. Abdomen fuscous-brown on dorsum; first two segments pale brown; crests fuscous. Legs grey; posterior pair whitish. Forewings triangular, costa slightly arched, apex rectangular, termen bowed on vein 4, wavy; reddish-brown or ochreous-brown; posterior to a line from ¼ dorsum to apex fuscous-brown, sharply defined; three slightly darker lines from costa, first from ¼ costa to near base of termen, outwardly curved, second from before middle, short and outwardly toothed, third outwardly oblique from beyond middle,

then curved inwards as a dentate line posteriorly edged with whitish, limiting fuscous-brown area, finally curved outwards to $\frac{3}{4}$ dorsum; limited by the sinus so formed is a pale tornal blotch, edged fuscous anteriorly; this contains an anterior whitish suffusion and beyond it a whitish dentate line; an irregularly dentate whitish subterminal line, partly edged with fuscous; wavy interrupted submarginal and terminal lines; cilia reddish-brown. Hindwings with termen rounded, dentate; fuscous-brown; a sharply defined triangular basal whitish-brown spot; an irregular transverse series of reddish-brown spots from $\frac{3}{4}$ dorsum to beyond middle, the first three darker; cilia brown.

North Queensland: Cooktown; Kuranda, in June. Queensland: Yeppoon. Four specimens.

Antarchaea chionosticha, n. sp.

χιονοστικτος, with snow-white dots.

♂, ♀, 27-34 mm. Head and thorax purple-grey. Palpi $1\frac{1}{4}$; whitish sprinkled with purple-reddish. Antennae pale grey barred with purple-reddish; in male shortly bipectinate (2), apical fifth simple. Abdomen ochreous-grey; a small basal crest fuscous. Legs whitish sprinkled with purple-fuscous. Forewings triangular, costa straight, apex pointed, termen slightly curved, not oblique; purple-grey sometimes with fine fuscous strigulae; costa pale with darker strigulae; minute white discal dots at $\frac{2}{5}$ and $\frac{3}{5}$, sometimes surrounded by reddish suffusion cilia purple-grey or fuscous, apices whitish, sharply defined. Hindwings with termen rounded; pale grey, darker towards termen; cilia as forewings.

Queensland: Biloela, near Thangool, in February. North-West Australia: Wyndham, in December. Five specimens.

Gen. Euzancla, nov.

εὐζαγκλος, well-sickled.

Tongue strong. Frons flat, not projecting. Palpi extremely long, ascending, recurved over forewings, widely diverging; terminal joint long, with a very dense ridge of scales posteriorly, so as to appear clubbed. Antennae in male unpectinate to $\frac{2}{3}$, thence bipectinate nearly to apex, but inner pectinations shorter outer pectinations very long. Thorax and abdomen without crests. Legs smooth. Forewings without areole, 7, 8, 9, 10, 11 stalked. Hindwings with 5 well developed, rather closely approximated at origin to 4.

The affinities of this curious genus are not clear, but it is probably allied to *Simplicia*.

Euzancla rhopalophora, n. sp.

ῥοπαλοφορος, club-bearing.

♂, 25 mm. Head, palpi, thorax, and abdomen brownish-grey. Antennae grey, stalk whitish towards base; outer pectinations in male 6, inner 2. Legs fuscous. Forewings triangular, costa straight to near apex, apex rounded, termen slightly bowed in middle, slightly oblique; brownish-grey, a broad median band, defined by fine whitish lines, anterior edge from $\frac{1}{3}$ costa to $\frac{1}{3}$ dorsum, outwardly curved, posterior edge from $\frac{2}{3}$ costa to $\frac{2}{3}$ dorsum, strongly sinuate, towards dorsum dentate; a fine whitish subterminal line, indented above middle, thence sinuate; cilia fuscous-brown, on upper part of termen apices whitish. Hindwings with termen slightly rounded; grey; a fine whitish subterminal line; cilia fuscous.

Queensland: Coolangatta, in March; one specimen.

Gen. Naarda Wlk.

Cat. Brit. Mus., xxxv., p. 1,694.

Allied to *Hypena* but without abdominal crest. The three Australian species are very similar, but may be readily distinguished by the male antennae.

Naarda calliceros, n. sp.

καλλικερως, with beautiful horns.

♂, 15-20 mm. Head, thorax, and abdomen grey or brownish-grey. Palpi 8; fuscous. Antennae fuscous or grey; imparipectinate, each tooth with lateral and apical ciliations, inner row of pectinations short, towards base absent, outer row 3. Legs fuscous; posterior pair grey. Forewings triangular, costa straight almost to apex, apex rectangular, termen straight, not oblique, rounded beneath; grey or brownish-grey, markings obscure; a small pale orange subcostal spot at ⅓ representing orbicular; another similar, rather larger, with a fuscous central dot, about middle representing reniform; an irregular fuscous subterminal line; a terminal series of fuscous dots; cilia grey. Hindwings and cilia grey.

Queensland: Bundaberg, in December; Brisbane, in September; Bunya Mountains (3,500 feet), in March; six specimens.

Naarda leptotypa, n. sp.

λεπτοτυπος, slenderly marked.

♂, ♀, 16-22 mm. Head, thorax, and abdomen greyish-brown. Palpi 8; dark grey. Antennae grey; in male shortly bipectinate, each tooth with a terminal bristle. Legs fuscous. Forewings triangular, costa straight, apex pointed, termen straight, slightly oblique, rounded beneath; greyish-brown; markings fuscous, rather obscure; a very fine dentate transverse line at ¼; a discal dot at ⅓; a second similar line about middle; closely following this two dots in a slight ochreous suffusion; an incomplete third line, whitish-edged posteriorly, at ¾; an indistinct subterminal line; several pale dots on apical half of costa; an interrupted terminal line; cilia grey, apices paler. Hindwings and cilia grey.

North Queensland: Dunk Island, in May. Queensland: Byfield, near Yeppoon, in October; Eidsvold. Five specimens.

NAARDA XANTHONEPHRA Turn.

Trans. Roy. Soc. S.A., 1908, p. 65.

Antennae in male laminate, each lamina bearing a tuft of long cilia and a longer bristle.

North Queensland: Kuranda, in March, April, and June; Atherton Tableland, in September and February.

Gen. HYPENA Schrank.

Type *H. rostralis* Lin., from Europe.

Of this widely distributed genus I have twelve Australian species, all of which are found on the Queensland coast. Four of them appear to be new and are here described. The others are:—

H. gypsophila Turn., Trans. Roy. Soc. S.A., 1903, p. 14. Cairns.

H. gonospilalis Wlk. Cairns; Innisfail; Atherton; Yeppoon; Nambour; Mount Tambourine; Macpherson Range (3,500 feet).

H. sylpha Butl. Brisbane; Stradbroke Island. North-West Australia: Wyndham.

H. masurialis Gn. Delt. and Pyr., p. 38. Darwin; Innisfail; Atherton; Palm Island; Townsville; Eungella; Eidsvold; Nambour; Brisbane; Stradbroke Island; Tweed Heads; Blackbutt; Toowoomba; Warwick; Lismore; Sydney. North-West Australia: Wyndham. Also from Lord Howe and Norfolk Islands; Ceylon; India; Africa.

H. subvittalis Wlk. Gayndah; Brisbane; Rosewood; Miles; Lismore; Gosford.

H. labatalis Wlk., xvi., p. 66. Herberton; Townsville. Also from Ceylon and India.

H. conscitalis Wlk., xxxiv., p. 1,509. Herberton; Innisfail; Palm Island; Townsville; Brisbane; Blackbutt. Also from Java and Ceylon.

H. laesalis Wlk., xvi., p. 62. Cairns; Townsville. Also from India.

Hypena acrocompsa, n. sp.

ἀκροκομψος, prettily tipped.

♂, ♀, 22-32 mm. Head, thorax, and abdomen grey. Palpi 6; grey. Antennae grey; ciliations in male ½. Legs fuscous sprinkled with whitish. Forewings triangular, costa straight, arched before apex, apex pointed, termen bowed, slightly oblique; fuscous; a broad grey dorsal streak; joining this in middle an oblique grey streak from ⅓ costa; orbicular represented by a fuscous pale-edged dot, reniform slightly indicated; a narrow postmedian grey fascia, near its inner edge a fuscous line from ⅘ costa to ⅔ dorsum, obtusely bent above and below middle; a small elongate grey-whitish apical blotch with two elongate blackish marks on its anterior edge; tornal area paler; a fuscous terminal line preceded by a whitish line; cilia fuscous with three very slender pale lines. Hindwings fuscous with a darker terminal line; cilia as forewings.

North Queensland: Cairns, in August; Magnetic Island, in July; Netherdale (Mackay District), in June. Queensland: Yeppoon, in October; Bundaberg, in June; Brisbane, in August, October and February; Stradbroke Island, in September. New South Wales: Lismore. Eleven specimens.

Hypena euryzostra, n. sp.

εὐζωστρος, broadly girdled.

♂, 30-32 mm. Head, thorax, and abdomen grey. Palpi 6, grey. Antennae grey; ciliations in male 1. Legs grey; anterior pair fuscous. Forewings triangular, costa straight to near apex, apex rounded, termen slightly rounded, slightly oblique, crenulate; grey more or less sprinkled with fuscous; markings fuscous; a broad median band, anteriorly suffused, posteriorly darker, anterior edge from ¼ costa to ¼ dorsum, deeply excavated below middle, posterior edge from ⅘ costa to ⅔ dorsum, strongly curved outwards above and below middle; a dark fuscous dot beneath ½ costa in median band; an interrupted twice waved subterminal line; a terminal series of dots; cilia grey sprinkled with fuscous. Hindwings with termen strongly rounded; grey; a fuscous terminal line; cilia grey.

North Queensland: Dunk Island, in May; Magnetic Island, in July; two specimens.

Hypena pelodes, n. sp.

πηλωδης, clay-coloured.

♂, ♀, 34-36 mm. Head and thorax brown. Palpi 6; brown. Antennae grey; ciliations in male 1½. Abdomen grey. Legs fuscous; posterior pair grey. Forewings triangular, costa straight almost to apex, apex pointed, termen bowed, slightly oblique; brown with some fuscous strigulae; an ill-defined fuscous median dot at ⅓; sometimes a smaller subcostal dot at ¼; an oblique darker shade limited by a line from ⅘ costa to ⅔ dorsum, not defined anteriorly; an oblique pale shade follows this, not defined posteriorly; a short oblique pale streak from apex; a dark subterminal shade; a fuscous terminal line; cilia fuscous. Hindwings fuscous with a darker terminal line; cilia grey.

North Queensland: Millaa-millaa and Ravenswood, in September and October. Queensland: Montville, in September; National Park (3,500 feet), in December. Six specimens.

Hypena orthographa, n. sp.

ὀρθογραφος, straightly marked.

♂, ♀, 30 mm. Head, thorax, and abdomen fuscous. Palpi 6; fuscous mixed with whitish appearing grey. Antennae grey; ciliations in male minute. Legs grey. Forewings triangular, costa straight to near apex, apex pointed, termen bowed, not oblique, rounded beneath; fuscous-grey; a minute whitish subcostal dot at $\frac{1}{3}$; a straight fuscous line from $\frac{2}{3}$ costa to $\frac{2}{3}$ dorsum, pale- or whitish-edged posteriorly; cilia fuscous-grey. Hindwings broad, termen strongly rounded; fuscous-grey; cilia fuscous-grey.

Broader winged than *H. masurialis*, and the posterior line transverse, not oblique. Superficially it resembles *Placerobela brachyphylla* Turn.

North Queensland: Cooktown, in May; Kuranda, in August; two specimens.

Family ANTHELIDAE.

Anthela prionodes, n. sp.

πριονωδης, like a saw.

♂, 40 mm. Head ochreous; face reddish-brown. Palpi 2; brownish. Antennae pale ochreous; pectinations in male 10, brownish. Thorax and abdomen ochreous. Legs fuscous; coxae and femora ochreous; anterior coxae reddish-brown in front. Forewings broadly triangular, costa slightly arched, apex rounded, termen rounded, not oblique; ochreous; basal $\frac{2}{3}$ suffused with brownish; markings fuscous; an outwardly curved line from costa near base to $\frac{1}{3}$ dorsum, broadly suffused on costa; discals small, white-centred, first at $\frac{1}{4}$, second before middle; an outwardly curved fine serrulate line from $\frac{2}{3}$ costa to $\frac{2}{3}$ dorsum; a subterminal series of dots; cilia ochreous. Hindwings ample, termen strongly rounded; as forewings but without first line and with only one discal, which is reduced to a fuscous dot. Underside similar but with two white-centred discals in hindwings.

Near *A. heliopa* Low., but in that species the postmedian is nearly straight or only very slightly curved, not serrulate, and arises from $\frac{3}{4}$ or $\frac{4}{5}$ costa.

North Australia: Brock Creek, in March; one specimen received from Mr. T. G. Campbell. Type in Museum of Economic Entomology, Canberra.

Family LASIOCAMPIDAE.

Gen. Lasiomorpha, nov.

λασιομορφος, hairy.

Eyes hairy. Palpi 3, porrect, clothed with long hairs; terminal joint concealed. Antennae in female shortly pectinate. Forewings with 2 from $\frac{1}{3}$, 3 from $\frac{3}{4}$, 6 and 7 stalked, 8 connate from upper angle of cell, 9 and 10 stalked. Hindwings with 2 from middle, 3 from $\frac{3}{4}$, cell short, upper margin $\frac{1}{4}$, lower $\frac{1}{3}$, discocellulars angled, lower strongly oblique, 6 from upper angle, 7 from $\frac{1}{2}$, anastomosing strongly with 12, forming a small subcostal cell, which gives off a strong single pseudoneurium from its base.

Peculiar in the family by the neuration of the hindwings, in which 7 and 11 are coincident and anastomose with 12.

Lasiomorpha rhabditis, n. sp.

ῥαβδιτις, streaked.

♀, 45 mm. Head, thorax and abdomen pale grey. Palpi pale grey, mixed beneath with dark fuscous hairs. Antennae pale grey; pectinations in female 2, dark fuscous. Legs whitish; anterior pair pale grey. Forewings elongate, oval-triangular, costa straight to $\frac{2}{3}$, thence gently arched, apex round-pointed, termen

rounded, strongly oblique; pale grey; some brownish suffusion on veins; markings fuscous; a median streak from base to $\frac{3}{8}$, there forming two sharp teeth, and continued inwards to $\frac{1}{3}$ dorsum; a short subdorsal streak near base; some fuscous suffusion on costa before middle; a fine streak from beneath $\frac{1}{4}$ costa to $\frac{3}{4}$, where it forms two sharp teeth, and is then lost in suffusion; five longitudinal streaks before termen, varying in length; three subterminal spots above tornus; cilia pale grey with fuscous bars. Hindwings with termen rounded; grey-whitish; cilia grey-whitish.

North Australia: Brock Creek, in April; one specimen received from Mr. T. G. Campbell. Type in Museum of Economic Entomology, Canberra.

Family LIMACODIDAE.

Susica miltochyta, n. sp.

μιλτοχυτος, suffused with red.

♂, 34-36 mm. Head and thorax pale red. Palpi $1\frac{1}{4}$; whitish-ochreous, upper surface reddish. Antennae grey-whitish; pectinations in male 6, shortening before and disappearing at $\frac{2}{3}$. Abdomen whitish. Legs whitish; anterior pair red with dark fuscous anterior bars on tibiae and tarsi. Forewings triangular, costa straight to near apex, apex rounded, termen rounded, not oblique; pale ochreous mostly suffused with pale red; a broadly suffused fuscous fascia from mid-dorsum to just before apex, where it is confluent with a similar subterminal fascia, which ceases well above tornus; cilia pale ochreous. Hindwings with termen strongly rounded; white; cilia white.

North Australia: Brock Creek, in March and April; two specimens received from Mr. T. G. Campbell. Type in Museum of Economic Entomology, Canberra.

Family PSCHYDIDAE.

Plutorectis pelloceros, n. sp.

πελλοκερως, grey-horned.

♂, 30-32 mm. Head fuscous. Antennae, including pectinations, grey. Thorax grey, becoming fuscous anteriorly. Abdomen and legs grey. Forewings elongate-triangular, costa nearly straight, slightly sinuate, apex rounded-rectangular, termen scarcely rounded, slightly oblique; grey; cilia grey, apices paler. Hindwings with termen slightly rounded; pale grey; cilia pale grey.

In the similar *P. lurida* Heyl. (*muris-olens* Luc.) the antennal pectinations are fuscous, the forewings much shorter and broader, and their apices more rounded.

North-West Australia: Wyndham, in November; two specimens received from Mr. T. G. Campbell. Type in Museum of Economic Entomology, Canberra.

Family CRAMBIDAE.

Gen. **Polyterpnes**, nov.

πολυτερπνης, much delighting.

Face with an acute anterior cone-shaped prominence. Tongue well developed. Labial palpi long, porrect, broadly dilated with appressed scales; terminal joint and maxillary palpi concealed. Antennae in male bipectinate, towards apex simple. Forewings with 2 from $\frac{3}{4}$, 3 from before angle, 4 and 5 connate from angle, 6 from upper angle, 7, 8, 9 stalked, 10 and 11 free. Hindwings with cubital pecten; 2 from $\frac{3}{4}$, 3 from before angle, 4 and 5 connate, 6 and 7 from upper angle, 7 anastomosing strongly with 12.

Perhaps allied to *Canusa*. In neuration it agrees with *Crambus*, but is very different in the head and palpi.

Polyterpnes polyrrhoda, n. sp.

πολυρροδος, abounding in roses.

♂, 22 mm. Head pale crimson. Palpi whitish with some pale crimson suffusion. Antennae whitish; pectinations in male 3, apical ⅓ simple. Thorax whitish with some pale crimson suffusion. Abdomen ochreous-whitish. Legs whitish; anterior pair faintly crimson-tinged. Forewings elongate-triangular, costa straight to ¾, thence arched, apex rounded, termen slightly rounded, slightly oblique; whitish suffused with pale crimson; a darker crimson suffusion at base; an outwardly curved crimson line from ⅓ costa to ⅔ dorsum; a similar but interrupted line from ¾ costa to ¾ dorsum; median space between lines dark crimson, which is continued to apex; a shining snow-white oblique line from apex inwards, narrowly edged and indented with fuscous, preceded by a snow-white spot in disc at ⅗; cilia whitish, bases pale crimson. Hindwings whitish; termen pale crimson; cilia whitish.

North-West Australia: Wyndham, in January; one specimen received from Mr. T. G. Campbell. Type in Museum of Economic Entomology, Canberra.

Gen. **Phanerobela**, nov.

φανεροβελος, with weapons displayed (palpi).

Tongue strong. Face rounded, not projecting. Labial palpi very long, slender, porrect; second joint long, loose-scaled towards apex beneath; terminal joint long, exposed, smooth, obtuse. Maxillary palpi triangular. Thorax and abdomen smooth. Legs smooth; outer spurs not much exceeding ½ inner. Forewings with 2 from ¾, 3 from angle, 4 and 5 connate, 6 from below angle, 7 separate, 8, 9, 10 stalked. Hindwings with cubital pecten; 2 from ¾, 4 and 5 stalked, 6 from upper angle connate with 7, 7 anastomosing with 12, which is approximated to cell.

Probably near *Platytes* Gn. The differences both in neuration and palpi are considerable.

Phanerobela niphospila, n. sp.

νιφοσπιλος, snow-spotted.

♀, 26 mm. Head, thorax and abdomen fuscous-brown; pectus white. Labial palpi 4½, terminal joint ⅓; fuscous-brown; extreme apex and extreme base white. Maxillary palpi nearly 1, almost equilateral-triangular; fuscous-brown; extreme apex whitish. Legs fuscous-brown; median portion of femora, basal portion of tibiae, and whole posterior tibiae whitish. Forewings elongate-triangular, costa straight to near apex, apex round-pointed, termen straight, rounded beneath, scarcely oblique; fuscous-brown; four white spots partly outlined with fuscous; first subcostal close to base, elongate-oval; second beyond first, similar but broader; third in disc beyond middle, broadly lunate, outwardly oblique; fourth on costa at ⅘, small, quadrangular, with one or two white dots beneath partly confluent with it; an incomplete subterminal series of blackish dots; cilia blackish with white bars. Hindwings with termen rounded; grey; cilia as forewings.

North Queensland: Dunk Island, in May; one specimen.

Family SCHOENOBIADAE.

Gen. **Dolichobela**, nov.

δολιχοβελος, with long darts (palpi).

Tongue absent. Labial palpi very long, slender, porrect; second joint very long; terminal joint moderate, obtuse. Maxillary palpi obsolete. Antennae in male thickened, slightly dentate, minutely ciliated. Middle legs very long; posterior legs short, otherwise normal. Forewings with 2 from ¾, 3 from before

angle, 4 and 5 connate from angle, 6 and 7 stalked from near upper angle, 8, 9, 10 stalked, 11 free. Hindwings without cubital pecten; 2 from ¼, 3 from angle, 4 and 5 stalked, 6 from upper angle, 7 anastomosing for about ⅓ of its length with 12.

The absence of maxillary palpi is unusual in this family.

Dolichobela celidograpta, n. sp.

κηλιδογραπτος, blotched.

♂, 24 mm. Head, thorax, and abdomen grey. Palpi 3½; grey-whitish. Antennae grey-whitish. Legs grey; anterior pair grey-whitish. Forewings triangular, costa straight, apex rounded, termen slightly rounded, moderately oblique; grey-whitish; a fuscous line on costa from near base to middle; an oblique postmedian fuscous blotch from ⅘ costa to fold beyond middle, deeply indented above fold; a fine crenulate grey subterminal line; space between this and blotch white; a broad suffused grey terminal line; cilia grey. Hindwings with termen rounded; grey; cilia grey.

Queensland: Toowoomba, in December; one specimen received from Mr. E. J. Dumigan.

Family PYRALIDAE.

Gen. **Anassodes**, nov.

ἀνασσωδης, queenly.

Tongue present. Labial palpi long, porrect, thickened with appressed scales; second joint rough-scaled above; terminal joint bent slightly downwards, obtuse. Maxillary palpi obsolete. Antennae of male bipectinate, towards apex simple. Posterior tibiae smooth-scaled. Forewings with 2 from ⅘, 3 from before angle, 4 and 5 from angle, 6 from upper angle, 7, 8, 9 stalked, 7 separating before 9, 11 free. Hindwings with 2 from ⅘, 3 from before angle, 4 and 5 from angle, 6 from upper angle, 7 anastomosing strongly with 12.

Type *A. mesozonalis* Hamps. Hampson referred this to his genus *Murgisca*, based on a single female example from the West Indies with shorter palpi and very differently shaped forewings. It belongs to his *Chrysauginae*.

ANASSODES MESOZONALIS, Hamps.

Ann. Mag. Nat. Hist. (8), xix., p. 362.

♂, 20 mm.; ♀, 24-26 mm. Head pale green. Palpi in male 4, in female 6; whitish. Antennae ochreous-whitish; pectinations in male 3, gradually shortening beyond middle, apical ¼ simple. Thorax pale green; anterior edge ochreous. Abdomen and legs ochreous-grey-whitish. Forewings elongate-triangular, costa nearly straight, apex rounded-rectangular, termen straight, slightly oblique; pale green; an oblique white bar from base of costa along dorsum to ¼, its external edge reddish-ochreous; a shining white inwardly oblique interrupted median fascia, each portion of which is edged with reddish-ochreous; cilia pale green, apices in male purple-reddish. Hindwings with termen slightly rounded; ochreous-whitish; cilia whitish.

North Australia: Brock Creek, in April. North Queensland: Stannary Hills, near Herberton. North-West Australia: Wyndham, in February. Three specimens.

Endotricha euphiles, n. sp.

εὐφιλης, lovely.

♂, 14-15 mm. Head, thorax, and palpi crimson; a fan-like expansile tuft of very long pale ochreous hairs beneath tegulae. Antennae pale grey; in male with tufts of long cilia (2). Abdomen pale ochreous. Legs whitish; anterior and [illegible] pairs crimson-tinged. Forewings elongate-triangular, costa straight, apex

rectangular, termen straight, not oblique, rounded beneath; crimson; a narrow yellow transverse fascia at ⅔, constricted in middle; some pale yellow costal striae beyond this; a fine short pale yellow line from costa before apex, continued by an indistinct fuscous line to tornus; a terminal series of fuscous dots; cilia crimson, on apical third of termen pale yellow. Hindwings with termen only slightly rounded; crimson; a yellow median fascia broadening towards dorsum, where it extends from tornus to middle; cilia crimson, on fascia pale yellow, on dorsum grey-whitish.

North Queensland: Cape York, in June; four specimens received from Mr. W. B. Barnard, who has the type.

Endotricha scioides, n. sp.

σκιοειδης, darkly shaded.

♂, ♀, 18-20 mm. Head, thorax, and palpi fuscous. Antennae grey; in male with a double series of tufts of long cilia (3). Abdomen fuscous; dorsum of median segments suffused with whitish. Legs fuscous with whitish tarsal rings. Forewings triangular, costa straight to ⅘, thence arched, apex rectangular, termen slightly rounded, slightly oblique; fuscous; markings whitish; an outwardly curved transverse fascia at ⅓, anteriorly sharply defined, posteriorly suffused; several costal dots; two short parallel transverse bars in disc beneath ¾ costa, more or less developed; a slender line from ⅚ costa to tornus, with an obtuse posterior projection above middle; terminal area beyond this partly suffused with whitish; a terminal series of dark fuscous dots; cilia fuscous, bases whitish, apices grey, below apex white. Hindwings with termen strongly rounded; whitish; a small defined fuscous basal area; two fine parallel curved fuscous lines from midcosta to tornus; a fuscous apical blotch; terminal dots and cilia as forewings.

Near *E. desmotona* Low., of which it may be a local race, although very differently coloured.

Queensland: Toowoomba, in October and December; two specimens.

Endotricha psoloptera, n. sp.

χολοπτερος, sooty-winged.

♂, 18-20 mm. Head and palpi dark fuscous. Antennae grey; in male with a double row of tufts of cilia (1½). Thorax dark fuscous; inner edge of tegulae brown-whitish. Abdomen dark fuscous; dorsum of sub-basal segments more or less brown-whitish; tuft brown-whitish. Legs fuscous; posterior pair partly brown-whitish. Forewings elongate-triangular, costa bisinuate, apex obtusely pointed, termen slightly rounded, slightly oblique; dark fuscous; a moderately broad brown-whitish transverse fascia before middle; some whitish costal dots; a whitish line from ⅚ costa to tornus, more or less bent outwards beneath costa; a brownish subcostal bar connecting fascia with postmedian line; cilia fuscous, bases whitish. Hindwings with termen strongly rounded; fuscous; an antemedian transverse fascia, brownish edged with whitish, or wholly whitish; cilia as forewings.

Allied to the preceding species, but structurally distinct.

North-West Australia: Wyndham, in December and January; three specimens received from Mr. T. G. Campbell. Type in Museum of Economic Entomology, Canberra.

Gauna callimochla, n. sp.

καλλιμοχλος, prettily barred.

♀, 20 mm. Head ochreous-brown; face whitish-grey. Palpi dark fuscous. Antennae grey, towards base whitish. Thorax grey-whitish. Abdomen grey;

apices of segments grey-whitish. Forewings elongate-triangular, costa straight to near apex, apex round-pointed, termen slightly rounded, slightly oblique; grey-whitish; markings dark fuscous; a broad basal transverse line; another at ⅓, the two connected by a narrow costal suffusion; costa beyond this with dark strigulae; a roundish subcostal spot at ⅔; a costal spot before apex, connected by a fine sinuous line with tornus; a terminal series of triangular dots; cilia grey, bases grey-whitish. Hindwings with termen slightly rounded; grey-whitish; two suffused fuscous transverse lines from mid-dorsum and tornus; cilia as forewings.

North-West Australia: Wyndham, in November; one specimen received from Mr. T. G. Campbell. Type in Museum of Economic Entomology, Canberra.

Orthaga trissosticha, n. sp.

τρισσοστιχος, three-lined.

♂, 24-28 mm. Head, thorax, and abdomen brownish. Palpi pale grey. Antennae pale grey; ciliations in male ½. Legs fuscous-brown. Forewings triangular, costa nearly straight, apex round-pointed, termen slightly rounded, moderately oblique; brownish-grey; markings fuscous; a fine sub-basal transverse line; another from midcosta to mid-dorsum, fine sub-basal transverse line; another from midcosta to mid-dorsum, more or less angled outwards in middle, preceded by a suffused costal spot; a finely dentate line from ¾ costa to dorsum before tornus; bent outwards in middle; a broad terminal suffusion; cilia grey with an interrupted fuscous line. Hindwings with termen rounded; as forewings but without sub-basal line.

North Australia: Adelaide River, in July. North Queensland: Kuranda, in November; Townsville, in June. Three specimens.

Family PYRAUSTIDAE.

Metasia serrulata, n. sp.

serrulatus, finely toothed.

♀, 17-24 mm. Head, thorax, and abdomen ochreous-grey-whitish. Palpi 2½; grey; a sharply-defined triangular inferior white area towards base. Antennae grey. Legs whitish. Forewings elongate-triangular, costa nearly straight, apex round-pointed, termen slightly rounded, slightly oblique; ochreous-grey-whitish; markings blackish; a transverse dentate line from ⅓ dorsum, not reaching costa; a subcostal dot just before middle, and a larger pale-centred spot just beyond middle; a finely dentate line from ¾ costa, gently curved outwards, then inwards beneath subcostal spot, and finally transverse to ⅔ dorsum; an interrupted terminal line; cilia grey. Hindwings with termen gently rounded; pale grey; cilia pale grey.

North-West Australia: Wyndham, in January; two specimens received from Mr. T. G. Campbell. Type in Museum of Economic Entomology, Canberra.

Family GLYPHIPTERYGIDAE.

Glyphipteryx argyrelata, n. sp.

ἀργυρηλατος, wrought in silver.

♂, 9-11 mm. Head and thorax blackish. Palpi with long-spreading hairs on lower surface of second joint; blackish, second joint with median and apical, terminal joint with median and subapical, white rings. Antennae blackish. Abdomen blackish; tuft above grey-whitish. Legs blackish with white rings. Forewings narrow, costa slightly arched, apex pointed, termen oblique; 7 and 8 stalked; dark bronzy; markings silvery, blackish-edged; six broad streaks from costa, first at ¼, short, second at ⅜, outwardly oblique, reaching fold, third just

beyond middle, slightly outwardly curved to tornus, fourth, fifth, and sixth at even intervals between this and apex, more whitish, very short and pointed; a dot on termen above middle connected with sixth costal streak; a thick tornal streak edged anteriorly by a thick blackish line; above this two dots in disc, first between it and third discal, second beneath fourth discal; cilia grey with a sub-basal line indented beneath apex, on apex wholly blackish. Hindwings and cilia grey.

Queensland: Bunya Mountains (3,500 feet), in February and March; nine specimens.

Family HYPONOMEUTIDAE.

Lactura clitodes, n. sp.

κλειτωδης, splendid.

♂, 28 mm. Head yellow. Palpi pale yellow. Antennae ochreous-grey; ciliations in male minute (1/6). Thorax reddish, anteriorly broadly yellow. Abdomen pale grey, posteriorly reddish. Legs yellow; anterior tibiae and tarsi reddish. Forewings suboval, costa strongly arched, termen obliquely rounded; 6 and 7 stalked; dark reddish; a broad yellow streak along costa, continued still broader round apex and termen; a yellow spot on dorsum before middle; central area occupied by a large circular whitish suffusion; cilia yellow. Hindwings with termen rounded; 4 and 5 connate; pale reddish; cilia pale reddish.

Queensland: Burleigh Heads, near Southport, in January; one specimen received from Mr. E. J. Dumigan.

Lactura haplochroa, n. sp.

ἁπλοχροος, simply coloured.

♂, ♀, 21-36 mm. Head leaden-grey or whitish-ochreous, its posterior edge reddish; face whitish-ochreous. Palpi reddish. Antennae leaden-grey; ciliations in male minute (1/8). Thorax leaden-grey with a whitish-ochreous or reddish posterior spot. Abdomen reddish; underside pale ochreous. Legs reddish; anterior and middle tibiae and tarsi sometimes grey. Forewings elongate-oval; costa moderately arched, apex rounded, termen obliquely rounded; 6 and 7 separate; leaden-grey; a narrow reddish streak on basal 1/3 of costa; cilia leaden-grey. Hindwings elongate, termen nearly straight; 4 and 5 separate; reddish; cilia whitish-ochreous.

North-West Australia: Wyndham, in February (T. G. Campbell); four specimens. Type in Museum of Economic Entomology, Canberra.

Family TINEIDAE.

Callicerastis orchestris, n. sp.

ὀρχεστρις, a dancer.

♂, ♀, 9-12 mm. Head dark fuscous; face pale brown. Palpi 4; second joint expanded with loose hairs towards apex; pale brown, apex of terminal joint fuscous. Forewings narrow, apex rounded; dark fuscous; a large elongate orange spot on mid-dorsum, partly edged with brilliant purple and blue scales; minute white costal marks at middle and 3/4, their apices opalescent purple; two opalescent purple dots arranged transversely in disc at 2/3; a similar subterminal dot above middle; cilia dark fuscous, apices whitish. Hindwings lanceolate; fuscous; cilia fuscous.

North Queensland: Eungella, in September (G. M. Goldfinch). Queensland: Brisbane Botanic Gardens, common in March and April, flying in shady places in late afternoon, alighting on upper surfaces of leaves and executing an agile and intricate dance on them before coming to rest.

Family COSSIDAE.

Zeuzera quieta, n. sp.

quietus, peaceful.

♂, 34 mm. Head grey-whitish. Palpi blackish. Antennae brownish; pectinations in male 4, ceasing abruptly at $\frac{3}{5}$. Thorax whitish-grey. Abdomen grey-whitish. Legs grey-whitish; tarsi blackish. Forewings elongate-triangular, costa nearly straight, slightly sinuate, apex rounded, termen slightly rounded, strongly oblique; whitish-grey with sparsely scattered transverse blackish strigulae; on costa these are reduced to dots; a subcostal series of short strigulae; a dorsal series of long strigulae interrupted on fold; four or five slender lines of approximated strigulae in terminal area; cilia very short, whitish-grey. Hindwings with termen strongly rounded; whitish-grey; a few indistinct discal strigulae; five or six terminal dots most developed towards tornus, blackish with blue reflections; cilia whitish-grey.

North-West Australia: Wyndham, in January; one specimen received from Mr. T. G. Campbell. Type in Museum of Economic Entomology, Canberra.

Gen. **Charmoses**, nov.

χαρμοσης, a delightful moth.

Palpi about 1, slender, smooth, ascending; terminal joint short, pointed. Antennae in male bipectinate to apex. Thorax with a posterior crest. Forewings with median cell long and rather narrow, upper branch of median ending opposite 6, lower opposite 5; areole large, not projecting; 2 from before angle, 3 from angle, 7 separate, 8 and 9 stalked, 11 from areole. Hindwings with median branched, but without median cell; 3, 4, and 5 separate, 6 and 7 connate, 12 separate.

The absence of the median cell of the hindwings is due to the coalescence of the intermedian crossbar with the lower branch of the median, as I have shown occurs in *Dyspessa* and *Stygia* (Trans. Ent. Soc., 1918, p. 159).

Charmoses dumigani, n. sp.

♂, 24 mm. Head white with fuscous median and transverse lines forming a cross; fillet and face brown. Palpi dark fuscous. Antennae whitish; pectinations in male 3, brownish. Thorax white; posterior crest brown mixed with dark fuscous. Abdomen grey with whitish rings. Legs dark fuscous with white rings; posterior pair mostly white. Forewings elongate-triangular, costa straight except at extremities, apex rounded, termen nearly straight, slightly oblique; white; a small brown basal patch broadly but interruptedly edged with blackish; a broad median fascia composed of numerous grey strigulae, mixed with some that are brown or blackish, its anterior edge indistinct, posterior well defined; terminal area with few grey strigulae except on a narrow terminal band; a circular blackish discal spot at $\frac{1}{3}$; cilia grey, on tornus white. Hindwings grey; cilia grey, apices white.

Queensland: Toowoomba, in November; three specimens received from Mr. E. J. Dumigan, an untiring collector, to whom I owe several interesting new species.

Gen. **Sympycnodes**, nov.

συμπυκνωδης, compressed.

Palpi very short, loosely rough-haired; terminal joint concealed. Antennae in male bipectinate, pectinations ceasing rather abruptly nearer middle than apex. Thorax with an anterior crest. Tibiae without spurs. Forewings with median undivided in cell, median cell consequently absent, areole large, much projecting; 2 from before angle, 3 from angle, 4 and 5 connate, 6 from near upper angle,

7 and 8 stalked from areole, 9 approximated to them at origin, 10 arising separately from areole, 11 from middle of cell shortly before areole. Hindwings with median cell broad but short; 2 from $\frac{3}{4}$, 3, 4, 5 separate, 6 and 7 separate, 12 free.

A development of *Xyleutes*, differing in the thoracic crest and absence of a median cell in the forewing.

Sympycnodes trigonocosma, n. sp.

τριγογοκοσμος, ornamented with triangles.

♂, 42 mm. Head whitish; face fuscous. Palpi $\frac{1}{4}$; fuscous. Antennae whitish, apical $\frac{1}{6}$ and pectinations fuscous; pectinations in male 3, ceasing rather abruptly after $\frac{3}{8}$. Thorax with a rounded anterior crest; whitish sprinkled with fuscous; a median anterior fuscous spot. Abdomen pale grey. Legs fuscous with whitish rings. Forewings narrow, posteriorly dilated, apex rounded, termen obliquely rounded; grey-whitish very sparsely strigulated with fuscous, more so towards dorsum; a fuscous costal triangle at $\frac{1}{4}$ reaching lower edge of cell; another smaller at $\frac{3}{4}$; cilia grey-whitish with some fuscous bars. Hindwings with termen slightly rounded; as forewings but without costal triangles.

Queensland: National Park (3,500 feet), in March; one specimen.

Xyleutes amphiplecta, n. sp.

ἀμφιπλεκτος, intertwining.

♂, 34-52 mm. Head grey. Palpi 1; grey. Antennae fuscous; pectinations in male 6, ceasing rather abruptly at $\frac{3}{8}$. Thorax grey; a black U-shaped mark, its curved end near anterior margin, edged internally with whitish, interrupted before posterior ends. Abdomen grey; apices of segments whitish. Legs grey. Forewings elongate, scarcely dilated, costa straight, apex rounded, termen obliquely rounded; grey closely strigulated with blackish; costal edge with numerous blackish dots, towards apex sometimes whitish; terminal area more or less whitish, the strigulae forming a fine network; usually a small blackish discal spot at $\frac{2}{3}$; cilia whitish barred with fuscous. Hindwings with termen slightly rounded; grey with a fine fuscous network; cilia as forewings.

Queensland: Dalby, in February; Milmerran and Charleville, in November. New South Wales: Brewarrina. Victoria: Birchip, in December and January. An inland species.

Xyleutes polyplecta, n. sp.

πολυπλεκτος, closely twined.

♂, 42 mm.; ♀, 64 mm. Head brown. Palpi 1; fuscous. Antennae brown; pectinations in male 5, ceasing at $\frac{3}{4}$. Thorax grey-brown. Abdomen grey. Legs grey. Forewings narrow, oval-oblong, costa slightly arched, apex rounded, termen obliquely rounded; grey with numerous closely packed fuscous strigulae; a suffused pale fuscous discal spot at $\frac{2}{3}$; cilia pale fuscous. Hindwings with termen slightly rounded; grey towards base grey-whitish in male; cilia grey.

North Australia: Bathurst Island; two specimens.

Culama mesogeia, n. sp.

μεσογειος, inland.

♂, 55 mm. Head and thorax grey. Palpi 1; grey. Antennae whitish-grey; pectinations in male 4. Legs whitish-grey with blackish rings. Forewings sub-oblong, costa straight to $\frac{3}{4}$, thence slightly rounded, apex rounded-rectangular, termen straight, moderately oblique; 7, 8, 9 stalked from areole; grey with short blackish lines and strigulae; these are strongest and longest from costa; in terminal area some coalesce to form an imperfect network; cilia grey. Hindwings elongate,

termen slightly rounded; whitish; a few grey strigulae near termen; cilia grey on apex and posterior half of termen, whitish on anterior half and dorsum.

The neuration is probably variable. In *C. australis* 7 may be separate, connate, or stalked with 8, 9. In one female of that species the neuration is anomalous in both forewings, 7 and 8 being stalked and separate from 9. The two species are very similar, but *C. mesogeia* may be distinguished by the whitish hindwings.

New South Wales: Broken Hill; one specimen.

Gen. **Archaeoses**, nov.

ἀρχαιοσης a primitive moth.

Palpi long, obliquely ascending, thickened with appressed scales; terminal joint short, obtuse. Antennae simple in both sexes. Thorax not crested. Tibial spurs stout and long. Forewings with median cell well developed, areole moderate, not projecting; 2, 3, 4, 5 equidistant, 2 from near angle, 6 well separate from 7, 7, 8, 9, 10 separate from areole, or 7 and 8 connate, 11 from middle of cell. Hindwings with median cell well developed; all veins separate.

Near *Dudgeona* in structure. In that genus 6 is approximated to 7 in both wings, and there is a strong thoracic crest.

Archaeoses neurotenes, n. sp.

νευροτενης, drawn with strings.

♂, 27-32 mm.; ♀, 42-44 mm. Head and thorax grey-brown. Antennae grey-whitish above, beneath fuscous. Abdomen ochreous-grey. Legs grey-brown. Forewings elongate-oblong, costa slightly arched apex and termen rounded; grey, partly brownish-tinged, with fine fuscous lines on veins; some minute costal dots before middle; an undefined discal blotch beyond middle, consisting of a dark brown reticulum with pale grey interstices; neural streaks more pronounced in terminal area, increasing in thickness towards margin; interspaces grey sprinkled with whitish; cilia fuscous with whitish bars. Hindwings with termen slightly rounded; dark grey; cilia dark grey; cilia grey; apices whitish.

Queensland: Burpengary, near Brisbane; Miles, in March; Adavale, in April; six specimens.

Family MICROPTERYGIDAE.

Sabatinca porphyrodes, n. sp.

πορφυρωδης, purple.

♀, 11 mm. Head and palpi brownish. Antennae, thorax, and abdomen dark fuscous. Legs whitish; tibiae and tarsi with dark fuscous rings; posterior tibiae and tarsi wholly dark fuscous. Forewings oval; dark fuscous with purple sheen; three white transverse fasciae; first minute, basal; second moderate, from ⅓ costa to mid-dorsum; third more slender, from ⅔ costa towards but not reaching termen above tornus; a submarginal series of minute orange dots around apex and termen; cilia fuscous. Hindwings oval; fuscous with purple sheen; cilia fuscous.

North Queensland: Ravenshoe, near Herberton, in September; one specimen taken on the wing late in the afternoon in a jungle track.

MISCELLANEA.

NOTES ON THE LIFE HISTORY OF THE BLACK PEACH APHIS.

By A. G. Edquist.

Aphis persicae niger Smith.

The writer has for many years studied the peach aphis in captivity on peach and nectarine trees, and as the observed facts have repeated themselves from year to year for many years, the following notes which deal principally with the perennation of the insect will, it is believed, prove valuable to students of commercial entomology.

From eggs, winged sexual females and males appear on the peach trees, usually in May, and feed on the back of the leaves. From the winged females, wingless sexual females are produced, and the winged males mate with the wingless sexual females. The latter lay eggs in the axil of the flower buds but not in the internodes. The eggs are glued in position with a sticky secretion that covers the eggs. Some of them may fall off with the bud scales or are washed off by rain, which softens the sticky secretion.

The eggs when laid are pea green in colour, gradually darkening, until at the end of 48 hours they become jet black. Each egg is about ·6 mm. long and ·3 mm. wide, and narrow-elliptical in shape.

Parasitisation of the Wingless Females.

When a green-coloured wingless aphis is parasitised, it changes colour and shrivels considerably. The green colour passes to a port wine shade. The aphis then begins to increase in bulk and its colour changes to the colour of light brown paper. In about four to six weeks after parasitisation the parasites emerge through a hole in the dried body of the aphis. From parasitised aphides of a light brown colour, taken on May 23 and June 29, parasites emerged on June 22 and July 1.

A wasp and a dipterous insect were obtained from parasitised individuals, but unfortunately the names of the parasites have not been determined.

Evening Meeting, September 8, 1932.

ABSTRACT OF THE PROCEEDINGS

OF THE

ROYAL SOCIETY OF SOUTH AUSTRALIA (Incorporated).

FOR THE YEAR FROM NOVEMBER 1, 1931, TO OCTOBER 31, 1932.

ORDINARY MEETING, NOVEMBER 12, 1931.

The President (Professor T. Harvey Johnston) in the chair, and 28 Members were present.

Minutes of the Annual Meeting, held October 8, 1931, were read and confirmed.

NOMINATION AS FELLOW.—Harry Rowland Oliphant, Research Assistant, Adelaide University, was read.

PAPERS—

"Some Characteristics of Soils used for Turf Wickets in Australia," by C. S. Piper, M.Sc. In discussing the paper, Dr. L. Keith Ward raised the point that an interesting matter for determination would be the yield of water absorbed by these soils under pressure. It is a matter of moment to decide whether to use a heavy or a light roller on a wicket affected by rain. Some soils used for cricket pitches yield their absorbed water more readily than others, and the use of the right roller may control the moisture content of the surface layer in such a manner as to produce a slow, easy wicket on which the ball cuts through, rather than a sticky wicket which makes the ball rise abruptly. It was suggested also that the specific character of the soil used in the pitches has an important bearing upon the style of play. A hard setting soil, like that of Merri Creek, in Victoria, makes the ball rise higher from the pitch and produces a tendency towards back play and towards the development of strokes behind the wicket. In contrast, the Bulli soil used in New South Wales does not cause the ball to rise so high, and consequently favours the development of forward strokes such as drives, from which scoring is done in front of the wicket. The risk of lifting the ball with the danger of being caught at mid-off or mid-on is much less in the case of wickets made from the less compact soil. Similarly, the character of the soil affects bowling, and it is noticeable that there is a tendency to bowl a shorter length on the hard setting pitches, since the rise of the ball makes it more difficult, or dangerous, to execute the full strokes that would result from short-pitched balls on wickets where the ball keeps relatively low. A quite reasonable development of such investigations as have been carried out at the Waite Agricultural Research Institute would be the acquisition of a knowledge of soils by a captain of the future who desires to be ready for all emergencies and changes in weather conditions. He might well be expected to call for the soil section on a new ground, and for details of the physical behaviour of the several layers in relation to its yield of water under pressure. Mr. A. A. Simpson and the President also discussed the paper.

"The Soils of the Southern Portion of the Hundred of Kuitpo, South Australia," by J. K. Taylor, B.A., M.Sc., and J. O'Donnell, B.Sc. (Agr.), Dip.For. In the absence of the authors, this paper was read by Professor J. A. Prescott.

Exhibits—

Mr. H. H. Finlayson exhibited and made some remarks upon a skin and mounted head of *Macropus parri*, from the Dawson Valley, Queensland, a species on which he had recently published data.

Miss N. H. Woods exhibited a fossil shell which, though of Pliocene age, contains about forty embryos. The shell was obtained from the Abattoirs bore.

Mr. A. M. Lea exhibited a collection of insects recently taken between the Everard Ranges in South Australia and the Warbarton Ranges in Western Australia by Mr. A. Brumby. Also a specimen of a dangerously poisonous weed, the European hemlock, grown in Adelaide.

Rev. J. C. Jennison exhibited edible sea worms of the South Seas, from Fiji, which are a common contribution to the foods of the natives.

Dr. L. Keith Ward showed some lantern slides illustrating various diagrammatic representations of the phylogeny of the Primates, drawn in accordance with the requirements of the radio-active time scale of Barrell and others. He drew special attention to the fact that many such diagrams which are printed in anthropological books and elsewhere fail to indicate the brevity of the Pleistocene Period as compared with the duration of the Tertiary Era, during which the Primates evolved. Stress was placed on the fact that, if the glacial conditions of the Pleistocene exerted a powerful influence over the evolution of *Homo sapiens*, there were important virgations of the phylogenitic tree in the Eocene and in the Oligocene, when glaciation was by no means so widespread as in the Pleistocene Period. In fact, the Oligocene climate is generally regarded as having been warm and equable, even if there was local glaciation of highlands in Europe and America during Eocene time. The question was raised as to whether heat, like cold, acted as a stimulus towards the evolutionary development of the Primates.

The President exhibited two triangular obsidian-bladed fighting picks from the Admiralty Islands, one of these has been presented to the S.A. Museum by Dr. H. E. Dunstone. The Admiralty Islands and North Central Australia are the only two localities at present known for stone blades of this character. At both places they are mounted as spear heads, knives, and as fighting picks. The question immediately arises as to whether the highly characteristic forms and uses have originated independently, or whether a cultural link exists between them. On the whole, the evidence appeared to favour a cultural link.

Ordinary Meeting, April 14, 1932.

The President (Professor T. Harvey Johnston) in the chair, and 66 Members were present.

Apologies were received from Dr. L. Keith Ward, Mr. C. T. Madigan, and Mr. J. H. Gosse.

Minutes of the Ordinary Meeting, held November 12, were read and confirmed.

Obituary.—The President referred to the severe loss sustained by the Society by the death of Mr. A. M. Lea. Mr. H. M. Hale read a Eulogy prepared by him, and said that the Council would deal with its publication in the Proceedings.

Election of Representative Governor to fill casual vacancy.—The President drew attention to the Act which governs the election of a Representative Governor of the Society on the Board of Governors of the Public Library, Museum and Art Gallery, and invited Professor Walter Howchin to explain the circumstances connected with an election to fill a casual vacancy, to the Fellows. Professor Howchin then read extracts from the Act, and a discussion followed.

It was then proposed by Professor J. Burton Cleland, seconded by Mr. W. H. Selway, and carried, "that the Society proceed with the election of a Representative Governor at this meeting."

Professor Walter Howchin then moved, and Professor J. Burton Cleland seconded, "that the whole question relative to the election of a Representative Governor be referred to a legal opinion by the Council." Carried.

Nominations were then called to fill the casual vacancy of a Representative Governor. Dr. Chas. Fenner nominated, and Mr. J. M. Black seconded, Dr. T. D. Campbell. Professor J. Burton Cleland nominated, and Mr. W. H. Selway seconded, Dr. Robert Pulleine. A ballot was taken, and the President declared Dr. T. D. Campbell duly elected.

Election of a Member of the Council.—The President called for nominations to fill the vacancy on the Council caused by the death of Mr. A. M. Lea. Professor J. Burton Cleland nominated, and Mr. J. F. Bailey seconded, Dr. Robert Pulleine. There being no other nominations, the President declared Dr. Pulleine duly elected.

Nomination as Fellow.—Horace Edgar Dunstone, M.B., B.S., J.P., Medical Practitioner, 124 Payneham Road, St. Peters, was read.

Election as Fellow.—Harry Rowland Oliphant, Research Assistant, Adelaide University. A ballot was taken, and Mr. Oliphant was declared elected.

Exhibits—

Dr. Robert Pulleine exhibited some cylindriconical stones, which were the shortest he had seen for their bulk.

Mr. W. J. Kimber exhibited a complete fossil *Pecten* obtained from the Cliffs at Port Noarlunga, and, for comparison, some Recent pectens of the same species from the Dutch East Indies. Also a stone from the Valley of the Kings, Egypt, which he suggested may have been fashioned by human agencies, and asked Fellows present for a possible explanation. The Rev. J. C. Jennison suggested it may be a cast of an ancient oil lamp. Professor J. A. Prescott agreed with the explanation given by Mr. Jennison, and added that it may be a relic of the Roman occupation.

The President then delivered an extremely interesting and instructive lecture on "Life in the Antarctic and Sub-Antarctic," which was illustrated by a large number of slides prepared from photographs taken during the recent British-Australian and New Zealand Antarctic Expedition, led by Sir Douglas Mawson. Professor J. Burton Cleland moved, and Sir Douglas Mawson seconded, a hearty vote of thanks to Professor Harvey Johnston for his lecture, which was carried with acclamation.

Special Meeting, May 12, 1932, at 7.50 p.m.

The President (Professor T. Harvey Johnston) in the chair, and 29 Members were present.

Consideration was given to an amendment to Rule 4 of Section IX. of the Rules and By-Laws.

The President referred to the irregularity which existed at present in the working of this Rule, by which a casual vacancy as the Representative Governor of the Society was filled, and read a recommendation from the Council.

Mr. H. M. Hale moved, and Mr. J. F. Bailey seconded, "that this recommendation, *i.e.*, that in Rule 4 of Section IX. of the By-Laws, the word 'Society' be struck out, and the word 'Council' substituted."

After discussion, Mr. B. S. Roach moved, and Mr. W. H. Selway seconded, an amendment as follows: *(a)* That the Representative Governor be elected by the Society at the Annual Meeting in October; *(b)* That a casual vacancy be filled by the Council, and confirmed by the Society at its next meeting. The President ruled that the amendment was out of order, as it effected an alteration to Rule 1 of Section IX., of which no notice had been given for discussion at this special meeting.

The motion was then put to the meeting, and by a show of hands declared carried.

ORDINARY MEETING, MAY 12, 1932, AT 8.10 P.M.

The President (Professor T. Harvey Johnston) in the chair, and 38 Members and Visitors were present.

Minutes of the Ordinary Meeting, held April 14, 1932, were read and confirmed.

Apologies were received from Professor J. A. Prescott, Rev. N. H. Louwyck, and Mr. J. H. Gosse.

The President extended a welcome to Flight-Lieutenant C. H. Noble, from Cairo, as a visitor.

ELECTION OF FELLOW.—Horace Edgar Dunstone, M.B., B.S., J.P., Medical Practitioner, 124 Payneham Road, St. Peters. A ballot was taken and Dr. Dunstone declared elected.

NOMINATION AS FELLOWS.—Ernest Stephen Harvey Gibson, B.Sc., Teacher, Technical High School, Thebarton, and 297 Cross Roads, Clarence Gardens. John William Evans, M.A. (Cantab.), Economic Entomologist, Waite Agricultural Research Institute, Glen Osmond. Duncan Campbell Swan, B.Sc., Economic Entomologist, Waite Agricultural Research Institute, Glen Osmond.

PAPER—

"The Astronomy of the Aranda and Luritja Tribes, Central Australia, by B. G. Maegraith, M.B., B.S., was read by Mr. N. B. Tindale. In the discussion which followed, the Rev. J. C. Jennison said that in the Northern Territory some of the natives regard the sun as the wife of the moon. At times the sun is taken ill, and disappears for awhile. The stars are the children, and the Milky Way is a great river. They regard the Southern Cross as a place where a fire is always burning. Dr. H. K. Fry said that some of the natives in Central Australia recognise the morning and evening star as one, and that he had met a race with no knowledge whatever of the stars. An explanation for this may be that they were afraid to talk about them. Dr. Chas. Chewings referred to the remarkable naming of certain parts of the Milky Way by natives, and explained a native legend of the origin of the two dark spots in the Milky Way. It was at a meeting of the Little Wallaby Tribe near the Finke River. An initiation ceremony was in progress. Two boys had passed through the major part of the ceremony, and were lying flat with their faces to the ground. Two girls, who were affianced to the boys, stole into the camp at a time when the elders were absent, placed the boys on their backs, and flew to the Milky Way. The spots represent the places where two feathers used in the initiation ceremony were dropped by the girls. Dr. T. D. Campbell and Mr. J. M. Black referred to the value of the paper and the special qualifications of Dr. Maegraith to undertake this particular branch of the study of the natives. The President said that he was particularly struck with the almost brotherly affection existing between old blind Mulda and Wapita, two natives in the camp where the principal work of the author had been carried out, and expressed the thanks of the Society to Mr. N. B. Tindale for the excellent resume of the salient points contained in the paper, prepared by him on behalf of Dr. Maegraith.

An extremely interesting and educational Lecturette was then delivered by Dr. Robert H. Pulleine, on "Water Relationships of Desert Plants." Dr. Pulleine sketched the outstanding features of the vegetation of the arid and semi-arid regions of the world. He pointed out that while Africa and America had on different lines developed a special succulent vegetation alongside sclerophytes, Australia had a rich sclerophytic flora with hardly any succulents. Among the few that are endemic to Australia, however, are two remarkable occurrences, an Anacampseros and a Sarcostemma, which supply two most useful items in support of Wegener's theory in "Die Enstehung der Continenten und Ozeanen." It was pointed out that sclerophytes tended to fade out and give place to succulents where

the rainfall became absolutely irregular and unreliable in effective quantity, and in places where moisture was received only from dew and mists. Thus the development of succulence is a measure of aridity. The factors determining the existence of plants in arid regions are largely determined by: (1) Moisture; (2) Grazing. The first is met with in: *(a)* sclerophytic xerophytes, by the most various mechanisms of economy in transpiration; *(b)* by direct water storing in underground root stems, stems and leaves accompanied often by the total or sub-total suppression of all vegetative organs, reaching at the highest point a smooth spherical mass without leaves or spines as in *Euphorbia obesa.* Grazing is met by: *(a)* geophily, the plant spreading by means of stolons, or underground shoots, some going down vertically; *(b)* unpalatability from the presence of tannin bitter principles, etc., which render an inviting plant nauseous to taste; *(c)* disguise, which must not be credited with much value, as it is hardly likely that grazing animals would be deceived by it. Resurrectionism, so called by Compton, is a useful protection against prolonged drought and grazing. It may be seen to advantage in the recovery of our saltbush and bluebush after having been apparently dead for years. Without vegetable hibernation, or suspension of life, our arid regions would be incapable of carrying any permanent vegetation. Dr. Pulleine showed photographs and living specimens, illustrating the development of succulence and the devices used by water-savers and water-storers to collect and conserve moisture.

EXHIBITS—

Mr. Herbert M. Hale exhibited the skull of a beaked whale *(Mesoplodon layardii)*, stating that no less than three specimens of this rare species had been stranded on South Australian coasts during the last twelve months. The whale possesses only a single pair of teeth, situated in the mandible, and with age these grow out on each side of the beak, eventually arching above it, and so seriously limiting the gape—a natural case of lockjaw. Owing to this unique characteristic the name "Strap-toothed Whale" has been applied to the creature.

An exhibit was left by Mr. H. H. Finlayson who had to leave the meeting early. The Secretary read an extract wherein Mr. Finlayson asked for the comment of the Fellows upon a specimen of an apparently bituminous material taken by him in a cave on the north face of Ayres Rock. The material is well known to bushmen in the interior, and apparently occurs in several of the Central Australian ranges. There is much speculation locally as to its nature and origin, the opinions generally expressed being: (1) that it is a product of bat excrement, and (2) it is an exudite from the rock itself. The material is prized by the local Afghans as an aphrodisiac, and there is some traffic in it amongst themselves. They say that the same product occurs in the ranges in Baluchistan.

The President drew attention to a series of addresses published in the Proceedings of the Linnean Society of London (March 30, 1932) relating to the work of Robert Brown, the Naturalist, who accompanied Captain Matthew Flinders in the "Investigator" during his exploration of various parts of the Australian coast. The occasion for the addresses was the celebration of the Centenary of Brown's discovery of the nucleus of the vegetable cell. Apart from his monumental work on the Australian Flora, and on the Botany of other regions, Brown is remembered as the discoverer of Brownian movement (1827), and of the streaming motion of protoplasm. He was one of the founders of the Royal Geographical Society.

ORDINARY MEETING, JUNE 9, 1932.

The President (Professor T. Harvey Johnston) in the Chair, and 33 Members were present.

Minutes of the Special and Ordinary Meetings, held May 12, 1932, were read and confirmed.

Apologies were received from Sir Chas. Martin, Mr. H. M. Hale, and Mr. J. H. Gosse.

The President read a letter received from Mr. J. F. Bailey, wherein he tendered his resignation as: (1) Member of the Council from even date; (2) Society's Representative on the Flora and Fauna Board from June 20, 1932; and (3) Member of the Society from September 30, 1932, owing to his early departure from this State. The President gave a brief resume of Mr. Bailey's work as the Director of the Botanic Gardens, and expressed the regret of all the Fellows in his loss as a Member and a friend, and on behalf of the Society wished Mr. and Mrs. Bailey and family a pleasant time and best wishes on returning to their old home in Queensland. Dr. Robert Pulleine, Mr. J. M. Black, and Professor J. Burton Cleland supported the remarks of the President. Mr. J. F. Bailey thanked the President and Fellows for their kind wishes, and intimated that he hoped to carry on his botanical work on his return to Brisbane.

The President then drew the attention of Fellows to the necessity of electing a Member of the Council to fill the casual vacancy causd by the retirement of Mr. Bailey, at the next Ordinary Meeting.

The Chairman then referred to the honour of Knighthood recently conferred upon Sir Macpherson Robertson. Mr. B. S. Roach moved, and Professor J. Burton Cleland seconded, that a letter of congratulation be sent to Sir Macpherson Robertson by this Society. Carried.

Ballot as Fellows.—Ernest Stephen Harvey Gibson, B.Sc., Teacher, Technical High School, Thebarton, and 297 Cross Roads, Clarence Gardens; John William Evans, M.A. (Cantab.), Economic, Entomologist, Waite Agricultural Research Institute; Duncan Campbell Swan, B.Sc., Economic Entomologist, Waite Agricultural Research Institute. A ballot was taken, and Messrs. Gibson, Evans, and Swan were declared elected.

Paper—

"Genealogical Studies of Australian Tribal Systems" was read by Dr. H. K. Fry, D.S.O. In the discussion which followed the following Fellows took part:—Mr. N. B. Tindale, Mr. A. A. Simpson, Dr. L. Keith Ward, and Mr. J. M. Black.

Exhibits—

Mr. C. T. Madigan exhibited a number of Obsidianites or Australites from his collection, which show some of the typical forms, including button, dumb-bell, oval, etc., found in Central Australia, and from the Nullarbor and Hampton Plains. Attention was drawn to the similarity of types and forms from these two localities. Also, limonite concretions which are often found in soils up to the size of a football. They are said to be hollow inside, and are undoubtedly empty shells when found open, but the exhibitor considers that when formed in this condition the inside material had been lost. One example from Second Valley was shown cut open and containing loose earthy filling. An example from the glacial sands of the Myponga Valley was found to contain a mass of marcasite coated with limonite. The latter shell or coating being from ·3 to ·5 inches in thickness and composed of limonite cemented sand and the inside marcasite enclosing sand grains. The specimen was broken open a year ago. Since then the marcasite has considerably decomposed and lost its yellow colour, and the inside material has become quite loose and friable. It is suggested that this is the origin of many of the limonite nodules—formation of marcasite concretions, subsequent oxidation of the marcasite and finally outward ingration of the limonite formed into the surrounding formation, thus leaving a centre of loose material.

Dr. W. Ternant Cooke exhibited a sample of ochre which was brought to Adelaide by Mr. H. H. Finlayson, who states that it was found "in hills 12 miles south-west of King's Creek, in the George Gill Range." Mr. Finlayson also states that the material is prized as a pigment by the aborigines, and is extensively traded

by them. The material is of a uniform rich red colour, interspersed by tiny white specks; it is greasy to the feel, and rather soft. Curiosity as to its actual content of ferric oxide resulted in finding that about 58% of Fe_2O_3 could be extracted by acid attack. Examination of the almost white residue left after removal of the iron disclosed about 30% of Si O_2, and at least 8% of tungstic oxide. The presence of tungsten, and to such a marked extent, is somewhat unusual in such a type of material.

Two blackboards were then placed in the Society's Rooms by the Government Geologist (Dr. L. Keith Ward), who explained that they would prove useful to authors in the presentation of papers involving geographical relations. The boards have drawn upon them:—*(a)* The World on Mercator's projection; *(b)* Australia with a graticule of 3°; *(c)* South Australia with a graticule of each degree of longitude and latitude; *(d)* South Australia and the Northern Australia with a graticule of 3°. The President thanked Dr. Ward for his thoughtful and generous gift, and assured him that the blackboards were a decided acquisition to the Society. It was then moved and seconded that the initials and date of the donor and draughtsman be painted on each board.

Professor Walter Howchin exhibited some ancient (Pleistocene, or older) consolidated alluvia from Port Moonta. The formation shows a section in the sea cilffs, near the jetty, 20 feet in thickness. The lower ten feet consist of fine to coarse sands impregnated and cemented by silica which, in places, takes the form of chalcedony. This bed covers the beach from the cliffs to below sea level, immense blocks defy the waves and litter the shore. Resting on this hard silicious base is a pebbly lateritic deposit (also ten feet in thickness), too soft to withstand the force of the waves within the tidal area. This ancient and extinct river had an east and west direction, and junctioned with the main north and south waterway which formerly flowed down the valley now drowned by the sea. The lateritic material was probably derived from the decomposition of the highly felspathoid and other crystalline rocks that are widely distributed over northern Yorke Peninsula. The formation of laterite is by a very slow process, so that its presence on the top of the ancient alluvium proves the latter to be of great age.

Dr. Robert Pulleine exhibited the haustoria of the Quondong attached to the root of a eucalypt. There were three large haustoria in a length of nine inches. The specimen was obtained in the garden of Mr. A. Morris, of Broken Hill.

Ordinary Meeting, July 14, 1932.

The President (Professor T. Harvey Johnston) in the chair, and 37 Members and Visitors were present.

Minutes of the Ordinary Meeting, held June 9, were read and confirmed.

Apologies were received from the Rev. N. H. Louwyck, and Mr. J. H. Gosse.

The President extended a welcome to Dr. H. E. Dunstone, and Messrs. D. C. Swan and J. W. Evans, as new Fellows.

The President then called for nominations to fill a casual vacancy on the Council, caused by the resignation of Mr. J. F. Bailey. Professor J. A. Prescott nominated, and Mr. E. H. Ising seconded, Professor J. Burton Cleland. There being no other nominations, the President declared Professor Cleland elected.

Nomination as Fellow.—Edgar Allen Mann, Bank Officer, c/o The Bank of Adelaide, Adelaide, was read.

Papers—

"Additions to the Flora of South Australia, No. 30," by J. M. Black, A.L.S. The President and Professor J. Burton Cleland discussed Mr. Black's paper.

"Botanical Notes of Anthropological Interest, from MacDonnell Downs, Central Australia," by J. Burton Cleland, M.D. In the discussion which followed, Dr. H. K. Fry, Mr. W. H. Selway, Mr. C. T. Madigan, and the President took part.

"An Examination of the Brown Coal of Noarlunga," by W. Ternant

Cooke, D.Sc., A.A.C.I. Dr. L. Keith Ward and Professor Walter Howchin discussed various points in Dr. Cooke's paper.

EXHIBITS—

Professor T. Harvey Johnston donated to the Society a framed picture of Sir Joseph Banks (based on Sir Joshua Reynolds' picture), whose name is so much associated with early Australian Geography and Botany. Professor J. Burton Cleland moved a hearty vote of thanks to the President for his gift, which was carried with acclamation.

Dr. Robert H. Pulleine showed specimens illustrating resurrectionism in *Kochia atriplex* and *Eremophila*. These specimens were collected in areas on the Gawler and Barrier ranges which were affected by the long drought of 1925-30, when most of the surrounding vegetation of the same, and other kinds, died. The phenomenon in each case consists of the development of the dead wood by new tissue spreading upwards from the root in one or more parallel processes. The dead wood is thus used as a scaffold for the spread of the new tissue, which seems to originate in subterranean resting cells in the cambium layer of the root.

Mr. N. B. Tindale exhibited a piece of native body armour made of rattan cane and a female figure of wood, from the Wanimo district of the Mandated Territory of New Guinea. The rattan armour consists of a chest cylinder with front and back projections from the upper rim. Similar armour is known among the natives of the Upper Fly River; only a few examples appear to have been collected. The female figure was obtained during a punitive expedition into previously uncontrolled country behind Wanimo. It was preserved in a sacred house associated with a small hamlet. The sacred house is used only by men and contains various ceremonial objects. The meaning of the present figure is unknown.

Dr. Chas. Chewings exhibited some Ordovician fossils found by Mr. R. Bedford at Christophers Pinnacle, near Henbury, on the Finke River.

Professor Walter Howchin exhibited a copy of the "New Geological Map of Australia that has just been published by Professor Sir T. W. Edgeworth David, together with a special volume of "Explanatory Notes" to accompany same. The map is based on the maps already published by the Geological Surveys of the various States, and enriched by the unequalled knowledge of the author from his personal acquaintance of the geology of the country, and a remarkable aptitude in unravelling the intricacies of geological structures and arriving at broad generalizations. The map is a model of clearness and high-class productions, is published by the Commonwealth Council for Scientific and Industrial Research, is in four equal sheets, each measuring three feet by two feet six inches. The amount of detail contained in the map is evident from the fact that no less than 76 distinct geological horizons have been included under separate colours and figures. The geological structure of the country is illustrated by eleven geological sections showing the succession of the geological Systems and the main tectonic features. The accompanying Explanatory Notes are something more than the title suggests, as the work, which runs into 177 pages, is a most valuable introduction to the Physical, Historical, Tectonic, Palaeontological and Economic elements of the Commonwealth, and includes ten text figures and eleven tables crowded with information. Professor Howchin then moved that a letter be sent to Sir Edgeworth, congratulating him on the production of the map, and wishing him a speedy recovery from his illness. The motion was seconded by Dr. L. Keith Ward, and carried.

Mr. J. M. Black presented an exhibit on behalf of Mr. E. H. Ising, consisting of a specimen of *Eucalyptus Kruseana*, F. v. M., from Karonie, W.A., which is a station on the Trans-Australian line, 68 miles east of Kalgoorlie, and collected by Mrs. P. Creagh. It was originally discovered in 1895 by J. D. Batt, at Frazer's Range, in South Western Australia, although the specimen is labelled "100 miles north of Israelite Bay." This is practically the same locality. It was

next found by Henry Deane, who was the consulting engineer for the building of the East-West line and who found one patch between 50 and 150 miles east of Kalgoorlie, in May, 1909. As Karonie is situated between these two points, the specimen now exhibited may easily have come from the same patch that Henry Deane collected them from. It is evidently a rare specimen, as these are the only two recorded localities from which it has been taken. It is called "Concertina bush" by Karonie residents. It is a low-growing bush of the mallee type—by low-growing is meant that the branches sweep the ground. Yet at no distance from this clump there is a fine upstanding tree of two stems, the branches starting fairly low but not near the ground. There are several stems like the mallee on the bush clumps with rough bark stems. It is an outstanding colour in the bush, the leaves being a grey-green, flowers pale yellow, and ripe pods, brown. The leaves, when crushed, smell strongly of eucalyptus oil. The two clumps known at Karonie grow in rocky ground.

Ordinary Meeting, August 11, 1932.

The Senior Vice-President (Professor J. A. Prescott) in the chair, and 25 Members and Visitors were present.

Apologies were received from the President (Professor T. Harvey Johnston), Dr. T. D. Campbell, and Professor J. Burton Cleland (who were in Central Australia with the Adelaide University and Museum Anthropological Expedition), Dr. Chas. Fenner, and Mr. J. H. Gosse.

Minutes of the Ordinary Meeting, held July 14, 1932, were read and confirmed.

Election as Fellow.—Edgar Allen Mann, Bank Officer, c/o Bank of Adelaide, Adelaide. A ballot was taken and Mr. Mann was declared elected.

Nomination as Fellow.—Percy Raymond Begg, B.D.Sc., L.D.S., Orthodontist, 219 North Terrace, Adelaide, was read.

Papers—

"New Australian Lepidoptera," by A. Jefferis Turner, M.D., F.E.S. It was agreed that this paper be taken as read.

"The Big Drop Method of Measuring Surface Tension," by E. S. H. Gibson, B.Sc. Mr. Roy S. Burdon, Mr. C. T. Madigan, and Professor J. A. Prescott discussed Mr. Gibson's paper.

"The Geology of the Eastern MacDonnell Ranges, Central Australia," by C. T. Madigan, M.A., B.E., F.G.S., who illustrated his remarks with lantern slides. Dr. Robert H. Pulleine, Dr. Chas. Chewings, Dr. L. Keith Ward, Professor Sir Douglas Mawson, and Professor J. A. Prescott discussed at length various points in connection with the paper, and pointed out the importance of Mr. Madigan's work.

Ordinary Meeting, September 8, 1932.

The President (Professor T. Harvey Johnston) in the chair, and 33 Members were present.

An apology was received from Dr. L. Keith Ward.

Minutes of the Ordinary Meeting, held August 11, 1932, were read and confirmed.

Election as Fellow.—Percy Raymond Begg, B.D.Sc., L.D.S., Orthodontist, 219 North Terrace, Adelaide. A ballot was taken and Mr. Begg was declared elected.

The President extended the heartiest congratulations of the Society to Mr. J. M. Black on being the recipient of the Müeller Medal, which was awarded to him at the recent meeting of the A.N.Z.A.A.S., at Sydney.

The President then extended the congratulations of the Society to Mr. M. Richard Freney, who was leaving within a few days for Europe for specialized

training in biological aspects of the wool industry. The Chairman drew the attention of the Fellows to a handsome volume published in connection with the Centenary of Marcelin Berthelot (1827-1927), and presented to this Society by the French Consul-General in Sydney on behalf of the French Government; also reminded the Fellows that the nominations for Officers for the year 1932-33 were due at noon on Monday, September 19, 1932.

PAPERS—

"The Parasites of the Stumpy-tail Lizard, *Trachysaurus rugosus*," by Professor T. Harvey Johnston, M.A., D.Sc. Mr. A. G. Edquist and Mr. J. M. Black took part in the discussion of Professor T. Harvey Johnston's paper.

"Some Botanical Features of the District between Cockatoo Creek and Alice Springs," by Professor J. Burton Cleland, M.D. Dr. Robert H. Pulleine, Mr. J. M. Black, Mr. B. S. Roach, Mr. A. A. Simpson, Mr. H. H. Finlayson, and the President discussed various points in connection with this paper.

"Notes on the Life History of the Black Peach Aphis," by A. G. Edquist. Dr. James Davidson discussed Mr. Edquist's paper.

"The Soils of the South Australian Mallee," by Professor J. A. Prescott, M.Sc., D.Sc., A.I.C., and C. S. Piper, M.Sc. Mr. C. T. Madigan and Mr. A. G. Edquist took part in the discussion which followed. The President expressed the thanks of the Society to the authors on the presentation of such a valuable paper.

ANNUAL MEETING, OCTOBER 13, 1932.

The President (Professor T. Harvey Johnston) in the chair, and 31 Fellows were present.

Minutes of the Ordinary Meeting, held September 8, 1932, were read and confirmed.

Apologies were received from Dr. James Davidson, Rev. N. H. Louwyck, and Mr. C. T. Madigan.

The President extended the congratulations of the Society to Professor Sir Douglas Mawson on having been elected President-elect of the Australian and New Zealand Association for the Advancement of Science.

The President then extended the congratulations of the Society to Professor J. A. Prescott on having had the degree of D.Sc. conferred on him by the University of Adelaide.

The Secretary read a letter received from Professor Sir T. W. Edgeworth David, expressing deep appreciation of the messages of sympathy sent by the Society in his illness, and also congratulations on the publications of the New Geological Map of Australia.

Dr. L. Keith Ward presented a Report on the discussions and resolutions passed at the Meeting of Delegates of the Royal Societies in Australia, held in Sydney. Professor J. A. Prescott, as the Co-Delegate, supported the remarks of Dr. Ward. It was then moved by Professor J. Burton Cleland, seconded by Mr. W. H. Selway, and carried, that the thanks of the Society be extended to the Delegates for the presentation of the Report.

The Secretary presented the ANNUAL REPORT of the Council for the year. It was moved by Dr. Chas. Fenner, seconded by Dr. L. Keith Ward, and carried, that the Report be adopted.

The Treasurer, Mr. B. S. Roach, presented the FINANCIAL STATEMENT of receipts and expenditure for the year, and intimated to the Members that he desired to tender his resignation as Treasurer to the Society owing to his many and varied duties, which required his whole attention. It was moved by Mr. W. Champion Hackett, seconded by Mr. A. A. Simpson, and carried, that the Financial Statement be adopted. Dr. L. Keith Ward drew the attention of the Fellows to the sterling character and outstanding ability of Mr. B. S. Roach as a Treasurer,

and asked the President to approach Mr. Roach with a view to reconsidering his decision.

The President expressed his very deep appreciation, and the thanks of the Society, to the Treasurer (Mr. B. S. Roach), the Secretary (Mr. Ralph W. Segnit), and the Editor (Professor Walter Howchin) for the valuable assistance given to him during his year as President, and the faithful services rendered to the Society by these Officers. It was moved by Professor J. A. Prescott, seconded by Professor J. Burton Cleland, and carried, that the expression of thanks be recorded in the Minutes.

Election of Officers for the Year 1932-1933.—The President read the nominations received: For President, Professor J. A. Prescott; Senior Vice-President, Mr. J. M. Black; Junior Vice-President, Dr. T. D. Campbell, and declared these Fellows duly elected. For Treasurer, Mr. B. S. Roach. The President informed the Fellows that as only one nomination had been received, and that Mr. Roach had only intimated that he desired to retire since nominations had closed, that he would have to declare him re-elected as Treasurer, and leave the question of resignation stand for further action, if desired by Mr. Roach. For Secretary, Mr. Ralph W. Segnit. Editor, Professor Walter Howchin. The President declared Mr. Segnit and Professor Howchin elected. Members of Council—Nominations were received for Dr. L. B. Bull, Dr. W. Christie, Professor J. Burton Cleland, Dr. James Davidson, Dr. Robert H. Pulleine, and Mr. J. G. Wood for the three vacancies. A ballot was taken and the President declared Professor J. Burton Cleland, Dr. James Davidson, and Dr. Robert H. Pulleine duly elected. For Auditors—Mr. W. Champion Hackett and Mr. O. Glastonbury.

Papers—

"*Caloprymnus campestris*, its Recurrence and Characters," by H. H. Finlayson.

"Preliminary Descriptions of two new Mammals from South Australia," by H. H. Finlayson.

"A Simple Apparatus for Degreasing Bones for Museum Purposes," by H. H. Finlayson.

Exhibit—

Mr. D. C. Swan exhibited living specimens of insects belonging to the order Protura, as yet unrecorded as occurring in South Australia. Remarks were made upon the primitive nature of these insects, and certain interesting features of their structure and biology were touched upon. The specimens were obtained at Glen Osmond.

ANNUAL REPORT

Presented at the Annual Meeting on October 13, 1932.

The average attendance of Fellows at the meetings held during the year has been 37.

The Senior Vice-President, Professor J. A. Prescott, acted as Chairman at one meeting during the absence of the President, who was in Central Australia.

Mr. J. M. Black received the congratulations of the Society on having been awarded the Müeller Medal by the Australian and New Zealand Association for the Advancement of Science at the meeting held in Sydney, 1932.

Professor Sir Douglas Mawson received the congratulations of the Society on being elected President-Elect of the Australian and New Zealand Association for the Advancement of Science.

Professor Sir T. W. Edgeworth David, an Honorary Fellow, received the congratulations of the Society on the publication of the "New Geological Map of Australia."

Sir Macpherson Robertson was congratulated by the Society on having had the distinction of Knighthood conferred upon him.

Dr. L. Keith Ward presented to the Society two blackboards with maps drawn on them, for the use of authors in the presentation of papers involving geographical relations.

The following Fellows took part in the Adelaide University and Museum Anthropological Expedition to Central Australia:—Professor T. Harvey Johnston, Dr. T. D. Campbell, Professor J. Burton Cleland, Mr. H. M. Hale, Dr. H. K. Fry, Mr. N. B. Tindale, and Mr. E. W. Holden.

During the year two of the Ordinary Meetings of the Society were dvoted to Special Subjects in the form of lectures, which were largely attended. The first was delivered by the President on "Life in the Antarctic and Sub-Antarctic," which was illustrated with lantern slides. The second was by Dr. Robert H. Pulleine on "Water Relationships of Desert Plants," which was illustrated by a number of characteristic plants.

Papers—

A Geological paper was read by Mr. C. T. Madigan.

Three Botanical papers were presented, one by Mr. J. M. Black, and two by Professor J. Burton Cleland.

A paper on the Chemistry of South Australian Brown Coal was read by Dr. W. Ternant Cooke.

Entomological papers were presented by Dr. A. Jefferis Turner and Mr. A. G. Edquist.

A Physics paper was read by Mr. E. S. H. Gibson.

Anthropological papers were contributed by Dr. H. K. Fry and Dr. B. G. Maegraith, of which the latter was read by Mr. N. B. Tindale.

Soil Survey papers were presented by Mr. J. K. Taylor, Mr. J. O'Donnell, Professor J. A. Prescott and Mr. C. S. Piper.

Zoological papers were read by Professor T. Harvey Johnston and Mr. H. H. Finlayson.

During the year the Society has suffered loss by death of two Fellows, Mr. H. H. Dutton, who was elected in 1911, and Mr. Arthur M. Lea, who was elected in 1897. An Obituary Notice (with portrait) of Mr. Lea appears on page 1.

The Membership of the Society shows a slight decrease. The number of Fellows elected during the year being 7. Four Fellows resigned, 2 died, and 1 was struck off the roll. The Membership Roll at the close of the year is:—Honorary Fellows, 5; Fellows, 161; Associates, 1. Total, 167.

The Council has met on 11 occasions of which two were special meetings, the attendance being as follows:—Professor T. Harvey Johnston, 10; Professor J. A. Prescott, 9; Mr. J. M. Black, 9; Mr. B. S. Roach, 8; Mr. Ralph W. Segnit, 11; Professor Walter Howchin, 11; Mr. J. F. Bailey, 6; Mr. Arthur M. Lea, 4; Mr. C. T. Madigan, 9; Sir Joseph Verco, 0; Dr. T. D. Campbell, 9; Mr. Herbert M. Hale, 9; Dr. Robert H. Pulleine, 4; Professor J. Burton Cleland, 4.

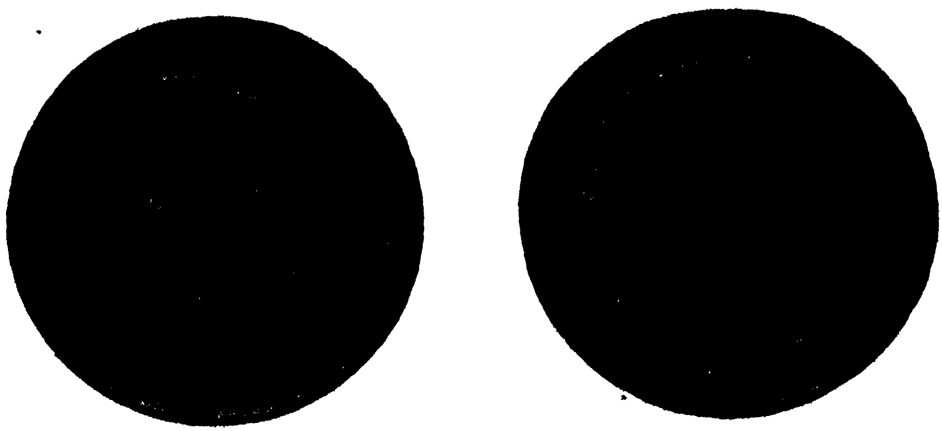
The President was away from one meeting due to his absence from the State. Professor J. A. Prescott was absent from two meetings while attending science meetings in Victoria. Mr. B. S. Roach was granted leave from one meeting to enable him to visit Victoria. Mr. H. M. Hale was granted leave from one meeting. Mr. Arthur M. Lea died in March. Mr. J. F. Bailey resigned as a member of the Council in June. owing to his departure from the State. Sir Joseph C. Verco's state of health prevented him from attending any meetings during the year. Mr. Robert H. Pulleine was elected as a member of the Council in April, and Professor J. Burton Cleland in July.

T. Harvey Johnston, *President.*

Ralph W. Segnit, *Secretary.*

THE SIR JOSEPH VERCO MEDAL.

The Council, on August 23, 1928, having resolved to recommend to the Fellows of the Society that a medal should be founded to give honorary distinction for scientific research, and that it should be designated the Sir Joseph Verco



Medal, was submitted to the Society at the evening meeting of October 11, 1928, and at a later meeting, held on November 8, 1928, when the recommendation of the Council was confirmed on the following terms:—

Regulations.

XI.—The medal shall be of bronze, and shall be known as the Sir Joseph Verco Medal, in recognition of the important service that gentleman has rendered to the Royal Society of South Australia. On the obverse side of the medal shall be these words: 'The Sir Joseph Verco Medal of the Royal Society of South Australia,' surrounding the modelled portrait of Sir Joseph Verco, while on the reverse side of the medal there shall be a surrounding wreath of eucalypt, with the words: 'Awarded to   for Research in Science,' the name of the recipient, and the year of the award. The Council shall select the person to whom it is suggested that the medal shall be awarded, and that name shall be submitted to the Fellows at an Ordinary Meeting to confirm, or otherwise, the selection of the Council, by ballot or show of hands. The medal shall be awarded for distinguished scientific work published by a Member of the Royal Society of South Australia."

Awards.

1929 Prof. Walter Howchin, F.G.S. 1930 John McC. Black.
1931 Prof. Sir Douglas Mawson, B.E., D.Sc., F.R.S.

ROYAL SOCIETY OF SOUTH AUSTRALIA (INCORPORATED).

Receipts and Payments for the Year ended September 30, 1932.

RECEIPTS.

	£	s.	d.	£	s.	d.
To Balance, October 1, 1931				728	5	6
„ Subscriptions				113	17	11
„ Use of Room and Lantern by other Societies	8	7	0			
„ Sale of Publications	7	2	11			
				15	9	11
„ Donation towards Publishing Paper—H. H. Finlayson				11	0	0
„ Interest—						
Savings Bank Account	21	16	9			
Transferred from Endowment Fund	148	17	3			
				170	14	0
				£1,039	7	4

PAYMENTS.

	£	s.	d.	£	s.	d.
By Transactions—						
Printing	186	16	9			
Illustrating	44	9	3			
Publishing	6	7	7			
				237	13	7
„ Library—						
Librarian	39	18	11			
Freight on Books	1	15	10			
				41	14	9
„ Sundries—						
Cleaning and Lighting	8	17	1			
Printing, Postages and Stationery	36	13	7			
Petties	2	13	0			
Insurance	6	15	0			
				54	18	8
„ Balance, September 30, 1932—						
Savings Bank of S.A.	586	19	2			
Bank of Australasia	118	1	2			
				705	0	4
				£1,039	7	4

Audited and found correct,

W. CHAMPION HACKETT } Hon.
O. GLASTONBURY, A.A.I.S., A.F.I.A. } Auditors.

B. S. ROACH, Hon. Treasurer.

Adelaide, October 11, 1932.

ROYAL SOCIETY OF SOUTH AUSTRALIA 'NCORPORATED)

ENDOWMENT FUND.

As 30, 1932.

(Capital £4,286 7d.)

	£	s.	s.	d.		s.	d.	£	s.	d.
1931—Octobei					1932—September 30.					
To Balance—					By Revenue Account			48	7	3
S.A. Goveinmen' Stock	064	18			„ Australian Consolidated Stock Face Value	0	0	0		
Savings Bank	4	8			„ Savings Bank Accoun	6	13	7		
	,069								13	7
Ad ment on Con on ver men Stock	217		13	7						
nter st Re ved			17	3						
								,435	0	0

ed and found correct,

W. CHAMPION HACKETT } Hon.
O. GLASTONBURY, A.A.I.S., A.F.I.A. } Auditors.

B. S. ROACH, Hon. Treasurer.

Adelaide, October 11, 1932.

THE ENDOWMENT AND SCIENTIFIC RESEARCH FUND.

1902.—On the motion of the late Samuel Dixon it was resolved that steps be taken for the incorporation of the Society and the establishment of an Endowment and Scientific Research Fund. Vol. xxvi., pp. 327-8.

1903.—The incorporation of the Society was duly effected and announced. Vol. xxvii., pp. 314-5.

1905.—The President (Dr. J. C. Verco) offered to give £1,000 to the Fund on certain conditions. Vol. xxix., p. 339.

1929.—The following are particulars of the contributions received and other sources of revenue in support of the Fund up to date:—

SUMMARY OF THE ENDOWMENT FUND.

(Capital £4,069 6s. 10d.)

Contributions.

	£	s.	d.	£	s.	d.	£	s.	d.
Donations—									
1908, Dr. J. C. Verco ...	1,000	0	0						
1908, Thomas Scarfe ..	1,000	0	0						
1911, Dr. Verco ...	150	0	0						
1913, Dr. Verco ...	120	0	0						
Mrs. Ellen Peterswald ...	100	0	0						
Small Sums ..	6	0	0						
				2,376	0	0			
Bequests—									
1917, R. Barr Smith ...	1,005	16	8						
1920, Sir Edwin Smith ..	200	0	0						
				1,205	16	8			
Life Members' Subscriptions ..				225	0	0			
*Interest and Discounts				156	3	10			
From Current Account ..				106	6	4			
							4,069	6	10

*Interest on investments has, in the main, been transferred to general revenue for the publication of scientific papers. See Balance-sheets.

GRANTS MADE IN AID OF SCIENTIFIC RESEARCH.

	£	s.	d.
1916, G. H. Hardy, "Investigations into the Flight of Birds" ..	15	0	0
1916, Miss H. A. Rennie, "Biology of *Lobelia gibbosa*" ..	2	2	0
1921, F. R. Marston, "Possibility of obtaining from Azine precipitate samples of pure Proteolytic Enzymes" ..	30	0	0
1921, Prof. Wood Jones, "Investigations of the Fauna and Flora of Nuyts Archipelago"	44	16	7

ROYAL SOCIETY LIBRARY.

List of Governments, Societies and Editors with whom Exchanges of Publications are made.

AUSTRALIA.

Australasian Institute of Mining and Metallurgy, Melbourne.
Bureau of Census and Statistics, Canberra.
Council for Scientific and Industrial Research, Melbourne.
Library of Commonwealth Parliament.

SOUTH AUSTRALIA.

Botanic Garden, Adelaide.
Mines Department, Adelaide.
Public Library, Museum, and Art Gallery of South Australia.
Royal Geographical Society of Australasia (S.A. Branch).
South Australian Institutes Association, Adelaide.
South Australian Museum, Adelaide.
South Australian Naturalist, Adelaide.
South Australian Ornithologist, Adelaide.
South Australian Parliamentary Library.
University of Adelaide.
Waite Agricultural Research Institute, Glen Osmond.

NEW SOUTH WALES.

Australian Museum, Sydney.
Botanic Gardens, Sydney.
Department of Agriculture, Sydney.
Linnean Society of New South Wales.
Mines Department, Sydney.
Public Library of New South Wales.
Royal Society of New South Wales.
Royal Zoological Society of New South Wales.
School of Public Health and Tropical Medicine, Sydney.
Technological Museum, Sydney.
University of Sydney.

QUEENSLAND.

Department of Agriculture, Brisbane.
Geological Survey, Brisbane.
Queensland Museum, Brisbane.
Public Library of Queensland, Brisbane.
Royal Society of Queensland, Brisbane.
University of Queensland, Brisbane.

TASMANIA.

Government Geologist, Mines Department, Hobart.
Public Library of Tasmania, Hobart.
Royal Society of Tasmania, Hobart.
University of Tasmania, Hobart.

VICTORIA.

Field Naturalists' Club of Victoria, Melbourne.
Government Botanist, National Herbarium, Melbourne.
Mines Department, Melbourne.
National Museum, Melbourne.
Public Library of Victoria, Melbourne.
Royal Society of Victoria, Melbourne.
University of Melbourne.

WESTERN AUSTRALIA.

Geological Survey Department, Perth.
Public Library of Western Australia, Perth.
Royal Society of Western Australia, Perth.
University of Western Australia, Perth.

ENGLAND.

British Museum Library, London.
British Museum (Natural History), South Kensington.
Cambridge Philosophical Society.
Cambridge University Library.
Conchological Society of Great Britain and Ireland.
Entomological Society of London.
Geological Society of London.
Geologists' Association, London.
Hill Museum, Witley, Surrey.
Imperial Institute, South Kensington.
Imperial Institute of Entomology, London.
Linnean Society of London.
Liverpool Biological Society.
Manchester Literary and Philosophical Society.
National Physical Laboratory, Teddington.
Rhodes House Library, Oxford.
Rothamsted Experimental Station, Harpenden.
Royal Botanic Gardens, Kew.
Royal Empire Society, London.
Royal Geographical Society, London.
Royal Microscopical Society, London.
Royal Society, London.
Science Museum, South Kensington.
Zoological Museum, Tring, Herts.
Zoological Society of London.

SCOTLAND.

Edinburgh Geological Society.
Geological Society of Glasgow.
Royal Society of Edinburgh.

IRELAND.

Royal Dublin Society.
Royal Irish Academy, Dublin.

ARGENTINE REPUBLIC.

Academia Nacional de Ciencias, Cordoba.
Facultad de Ciencias Medicas, Buenos Aires.

AUSTRIA.

Akademie der Wissenschaften, Vienna.
Geologische Bundesanstalt, Vienna.
Naturhistorische Museums, Vienna.
Zoologisch-Botanische Gesellschaft, Vienna.

BELGIUM.

Académie Royale de Belgique, Brussels.
Instituts Solvay, Brussels.
Musée Royale d'Histoire Naturelle de Belgique, Brussels.
Société Entomologique de Belgique, Ghent.
Société Royale de Botanique de Belgique, Brussels.
Société Royale des Sciences de Liège.
Société Royale Zoologique de Belgique, Brussels.

BRAZIL.

Instituto Oswaldo Cruz, Rio de Janeiro.
Museu Paulista, Sao Paulo.

CANADA.

Canadian Geological Survey, Ottawa.
Department of Agriculture, Ottawa.
National Research Council of Canada, Ottawa.
Nova Scotian Institute of Science, Halifax.
Royal Canadian Institute, Toronto.
Royal Society of Canada, Ottawa.
University of British Columbia, Vancouver.

CHINA.

Geological Survey of China, Peiping.
Institute of Biology, National Library of Peiping.

CZECHO-SLOVAKIA.

Ceskoslovenska Botanicka Spolecnost, Prague.

DENMARK.

Conseil Permanent International pour l'Exploration de la Mer.
Danske Naturhistorisk Forening. Copenhagen.
Kobenhavn Universitets Zoologiske Museum.
K. Danske Videnskabernes Selskabs. Copenhagen.

FINLAND.

Academiae Scientiarum Fennicae, Helsinki.
Societas Entomologica Helsingforsiensis.
Societas Scientiarum Fennica, Helsingfors.

FRANCE.

Muséum National d'Histoire Naturelle, Paris.
Société des Sciences Naturelles de l'Ouest de la France, Nantes.
Société Entomologique de France, Paris.
Société Géologique de France, Paris.
Société Linnéenne de Bordeaux.
Societe Linnéenne de Normandie, Caen.

GERMANY.

Bayerische Akademie der Wissenschaften zu München.
Berliner Gesellschaft für Anthropologie, Ethnologie, und Urgeschichte.
Bibliothek der Botanischen Gartens und Museums, Berlin.
Fedde, F.: Repertorium specierum novarum regni vegetabilis, Berlin.
Gesellschaft der Wissenschaften zu Göttingen.
Gesellschaft für Erdkunde zu Berlin.
K. Leopoldinische Deutsche Akademie de Naturforscher, Halle.
Naturforschende Gesellschaft, Freiburg.
Preussische Akademie der Wissenschaften, Berlin.
Senckenbergische Bibliothek, Frankfürt a. M.
Zoologische Museum der Universitat, Berlin.
Zoologische Staatsinstitut und Zoologische Museum, Hamburg.

HAWAIIAN ISLANDS.

Bernice Pauahi Bishop Museum, Honolulu.
Hawaiian Entomological Society, Honolulu.

HOLLAND.

Musée Teyler, Harlem.
Rijks Herbarium, Leiden.

HUNGARY.

Hydrological Dept., Hungarian Geological Soc., Budapest.
Musée National Hongrois, Budapest.

INDIA.

Colombo Museum.
Government Museum, Madras.
Geological Survey of India, Calcutta.
Royal Asiatic Society, Bombay Branch and Malayan Br.
Zoological Survey of India, Calcutta.

ITALY.

Laboratorio di Entomologia, Bologna.
Laboratorio di Zoologia Agraria, Milan.
Laboratorio di Zoologia Generale e Agraria, Portici.
Società di Scienze Naturali ed Economiche, Palermo.
Società Entomologica Italiana, Genova.
Società Italiana di Scienze Naturali, Milano.
Società Toscana di Scienze Naturali, Pisa.

JAPAN.

Hiroshima University.
Kyōto Imperial University.
Ohara Institute for Agricultural Research, Kurashiki.
Taihoku Imperial University.
Tokyo Imperial University.

MEXICO.

Instituto de Biologia, Chapultepec.
Instituto Geológico de Mexico.
Sociedad Cientifica "Antonio Alzate." Mexico.

NEW ZEALAND.

Auckland Institute and Museum.
Dominion Museum, Wellington.
New Zealand Institute, Wellington.
Otago University Museum, Dunedin.
Philosophical Institute of Canterbury, Christchurch.

NORWAY.

Bergens Museum, Bergen.
Kongelige Norske Videnskabers Selskabs, Trondheim.
Tromso Museum.

PHILIPPINE ISLANDS.

Philippine Journal of Science, Manila.

POLAND.

Société Botanique de Pologne, Warszawa.
Société Polonaise des Naturalistes "Kopernik," Lwow.

RUSSIA.

Academie of Sciences, Leningrad.
Comité Géologique de Russie, Leningrade.

SPAIN.

Instituto Nacional de Segunda Ensenanza de Valencia.
Real Academia de Ciencias y Artes, Barcelona.

SWEDEN.

Entomologiska Föreningen i Stockholm.
Geologiska Föreningen, Stockholm.
Stockholm's Högskolas Bibliotek, Stockholm.
Regia Societas Scientiarum Upsaliensis, Upsala.

SWITZERLAND.

Naturforschende Gesellschaft, Basel.
Société de Physique et d'Histoire Naturelle de Genève.
Société Neuchâteloise des Sciences Naturelles, Neuchâtel.
Société Vaudoise des Sciences Naturelles, Lausanne.
Zentralbibliothek, Zürich.

UNION OF SOUTH AFRICA.

Albany Museum, Grahamstown.
Geological Society of South Africa, Johannesburg.
Royal Society of South Africa, Cape Town.
South African Museum, Cape Town.
South African Association for the Advancement of Science, Johannesburg.

UNITED STATES.

Academy of Natural Sciences of Philadelphia.
Academy of Science of St. Louis.
American Academy of Arts and Sciences, Boston.
American Chemical Society, Columbus, O.

American Geographical Society, New York.
American Microscopical Society, Manhattan, Kans.
American Museum of Natural History, New York.
American Philosophical Society, Philadelphia.
Arnold Arboretum, Jamaica Plain, Mass.
Biological Survey of the Mount Desert Region, Bar Harbour, Me.
Boston Society of Natural History, Boston, Mass.
Brooklyn Institute of Arts and Sciences.
California Academy of Sciences, San Francisco.
Californian State Mining Bureau, San Francisco.
California, University of, Berkeley, Cal.
Chicago Academy of Sciences.
Citrus Experiment Station, Riverside, Cal.
Connecticut State Library, Hartford, Conn.
Cornell University, Ithaca, N.Y.
Denison Scientific Association, Granville, O.
Field Museum of Natural History, Chicago, Ill.
Franklin Institute of the State of Pennsylvania, Philad.
Harvard Museum of Comparative Zoology, Cambridge, Mass.
Illinois State Natural History Survey, Urbana, Ill.
Illinois University Library, Urbana, Ill.
Indiana Academy of Science, Indianapolis.
Johns Hopkins University, Baltimore, Md.
Kansas University, Lawrence, Kans.
Marine Biological Laboratory, Wood's Hole, Mass.
Maryland Geological Survey, Baltimore, Md.
Michigan University, Chicago.
Missouri Botanical Garden Library, St. Louis, Mo.
National Academy of Science, Wash'ngton, D.C.
National Geographic Society, Washnigton, D.C.
New York Academy of Sciences, New York.
New York Public Library.
New York State Library, Albany, N.Y.
Ohio State University Library, Columbus, O.
Princeton University, Princeton, N.J.
San Diego Society of Natural History, San Diego, Cal.
Smithsonian Institution and Bureau of Ethnology, Washington.
United States Department of Agriculture, Washington, D.C.
United States Geological Survey, Washington, D.C.
United States National Museum, Washington, D.C.
Wagner Free Institute of Science, Philadelphia, Pa.
Washington University, St. Louis, Mo.
Yale University Library, New Haven, Conn.

URUGUAY.

Museo de Historia Natural de Montevideo.

LIST OF FELLOWS, MEMBERS, ETC.

AS EXISTING ON SEPTEMBER 30, 1932.

Those marked with an asterisk (*) have contributed papers published in the Society's Transactions. Those marked with a dagger (†) are Life Members.

Any change in address or any other changes should be notified to the Secretary.

Note.—The publications of the Society will not be sent to those whose subscriptions are in arrear.

Date of Election.

HONORARY FELLOWS.

1910. *BRAGG, SIR W. H., O.M., K.B.E., M.A., D.Sc., F.R.S., Director of the Royal Institution, Albemarle Street, London (Fellow 1886).
1926. *CHAPMAN, F., A.L.S., National Museum. Melbourne.
1897. *DAVID, SIR T. W. EDGEWORTH, K.B.E., C.M.G., D.S.O., B.A., D.Sc., F.R.S. F.G.S., Emeritus Professor of Geology, University of Sydney, Coringah, Sherbroke Road, Hornsby, N.S.W.
1898. *MEYRICK, E. T., B.A., F.R.S., F.Z.S., Thornhanger, Marlborough, Wilts, England.
1894. *WILSON, J. T., M.D, Ch.M., F.R.S., Professor of Anatomy, Cambridge University, England.

FELLOWS.

1926. ABEL, L. M., Chapman Camp, British Columbia.
1925. ADEY, W. J., 32 High Street, Burnside, S.A.
1927. *ALDERMAN, A. R., M.Sc., F.G.S., West Terrace, Kensington Gardens, S.A.
1931. ANDREW, REV. J. R., Woodside.
1929. ANGEL FRANK M., Box 1327G, G P.O, Adelaide.
1895. †*ASHBY, EDWIN, F.L.S., M.B.O.U., Blackwood, S.A.—**Council**, 1900-19; **Vice-President**, 1919-21.
1902. *BAKER, W. H., King's Park, S.A.
1926. BECK, B. B., 127 Fullarton Road, Myrtle Bank, S.A.
1932. BEGG, P. R., B.D.Sc., L.D.S., 219 North Terrace, Adelaide.
1928. BEST, R. J., M.Sc., A.A.C.I., Waite Agricultural Research Institute, Glen Osmond.
1928. *BEST, Mrs. E. W., M.Sc., Claremont, Glen Osmond.
1931. BIRCH, H. McI., M.R.C.S., M.R.C.P., Mental Hospital, Parkside.
1930. BIRKS, W. R., B.Sc.
1907. *BLACK, J. M., A.L.S., 82 Brougham Place, North Adelaide—**Sir Joseph Verco Medal**, 1930; **Council**, 1927-1931; **Vice-President**, 1931-.
1924. BROWNE, J. W., B.Ch., 169 North Terrace, Adelaide.
1916. *BULL, LIONEL B., D.V.Sc., Laboratory, Adelaide Hospital
1923. BURDON, ROY S., B.Sc., University of Adelaide.
1921. BURTON, R. J., Belair.
1922. *CAMPBELL, T. D., D.D.Sc., Dental Dept., Adelaide Hospital, Frome Road, Adelaide—**Rep.-Governor**, 1932-; **Council**, 1928-32; **Vice-President**, 1932-.
1907. *CHAPMAN, R. W., C.M.G., M.A., B.C.E., F.R.A.S., Professor of Engineering and Mechanics, University, Adelaide—**Council**, 1914-22.
1931. *CHEWINGS, CHAS., Ph.D., F.G.S., "Alverstroke," Glen Osmond.
1929. CHRISTIE, W., M.B., B.S., Education Department, Flinders Street, Adelaide.
1895. *CLELAND, JOHN B., M.D., Professor of Pathology, University, Adelaide—**Council**, 1921-26, 1932-; **President**, 1927-28; **Vice-President**, 1926-27.
1930. COLLINS, F. V., B.V.Sc., Green Road, Woodville.
1930. COLQUHOUN, T. T., M.Sc., University, Adelaide.
1907. *COOKE, W. T., D.Sc, A.A.C.I., Lecturer, University of Adelaide.
1929. *COTTON, BERNARD C., S.A. Museum, Adelaide.
1924. DE CRESPIGNY, C. T. C., D.S.O., M.D., 219 North Terrace, Adelaide.
1916. DARLING, H. G., Franklin Street, Adelaide.
1929. DAVIDSON, JAMES, D.Sc., Waite Agricultural Research Institute, Glen Osmond—**Council**, 1932-.
1928. DAVIES, J. G., B.Sc., Ph. D., Waite Agricultural Research Institute, Glen Osmond.
1927. *DAVIES, Prof. E. HAROLD, Mus.Doc., The University, Adelaide.
1927. DAWSON, BERNARD, M.D., F.R.C.S., Otago University, Dunedin, New Zealand.
1930. DIX, E. V., Glynde Road, Firle.
1915. *DODD, ALAN P., Prickly Pear Laboratory, Sherwood, Brisbane.
1932. DUNSTONE, H. E., M.B., B.S., J.P., 124 Payneham Road, St. Peters.
1921. DUTTON, G. H., B.Sc., Agricultural High School. Murray Bridge.
1931. DWYER, J. M., M.B., B.S., Adelaide Hospital.

Date of Election.

1902. *EDQUIST, A. G., 19 Farrell Street, Glenelg.
1918. *ELSTON, A. H., F.E.S.. "Llandyssil," Aldgate.
1925. ENGLAND, H. N., B.Sc., Commonwealth Research Station, Griffith, N.S.W.
1932. EVANS, J. W., M.A., Waite Agricultural Reasearch Institute, Glen Osmond.
1917. *FENNER, CHAS. A. E., D.Sc., 42 Alexander Avenue, Rose Park—**Rep.-Governor,** 1929-31; **Council,** 1925-28; **President,** 1930-31; **Vice-President,** 1928-30; **Secretary,** 1924-25; **Treasurer,** 1932-.
1927. *FINLAYSON, H. H., The University of Adelaide.
1929. FRENEY, M. RAPHAEL.
1929. FRENEY, M. RICHARD.
1931. FREWIN, O. W., M.B., B.S., Woodville
1923. *FRY, H. K., D.S.O., M.B., B.S., B.Sc., Glen Osmond Road, Parkside.
1930. GARRETT, S. D., B.A., Waite Agricultural Research Institute, Glen Osmond.
1932. *GIBSON, E. S. H., B.Sc., 297 Cross Roads, Clarence Gardens.
1919. †GLASTONBURY, O. A., Adelaide Cement Co, Brookman Buildings, Grenfell Street.
1923. GLOVER, C. R. J., Stanley Street, North Adelaide.
1927. GODFREY, F. K., Robert Street, Payneham, S.A.
1904. GORDON, DAVID, 72 Third Avenue, St. Peters.
1925. †GOSSE, J. H., Gilbert House, Gilbert Place, Adelaide.
1880. *GOYDER, GEORGE, A.M., B.Sc., F.G.S., 232 East Terrace, Adelaide.
1910. *GRANT, KERR, M.Sc., Professor of Physics, University, Adelaide—**Council,** 1912-15.
1931. GRAY, JAMES T., Orroroo, S.A.
1904. GRIFFITH, H., Hove, Brighton.
1916. HACKETT, W. CHAMPION, 35 Dequetteville Terrace, Kent Town.
1927. *HACKETT, Dr. C. J., 196 Prospect Road, Prospect, S.A.
1922. *HALE, H. M; The Director, S.A. Museum, Adelaide—**Council,** 1931-.
1930. HALL, F. J., Adelaide Electric Supply Coy., Ltd., Adelaide.
1922. *HAM, WILLIAM, F.R.E.S., 112 Edward Street, Norwood.
1916. †HANCOCK, H. LIPSON, A.M.I.C.E., M.I.M M., A.Am.I.M.E, Bewdley, 66 Beresford Road, Bellevue Hill, Rose Bay, Sydney.
1924. HAWKER, Captain C A. S., M.A., M.H R., North Bungaree, via Yacka, South Australia.
1896. HAWKER, E. W., M.A., LL.B., F.C.S., East Bungaree, Clare.
1928. HAWKER, M. S., Adelaide Club, North Terrace.
1923. HILL, FLORENCE McCOY M., B.S., M.D., University of Adelaide.
1927. HOLDEN, E. W., B.Sc., Dequetteville Terrace, Kent Town, S.A.
1929. HOSKING, JOHN W., 77 Sydenham Road, Norwood.
1930. HOSKING, J. S., B.Sc., Waite Agricultural Research Institute, Glen Osmond
1924. *HOSSFELD, PAUL S., M.Sc., Office of Home and Territories, Canberra.
1883. *HOWCHIN, PROFESSOR WALTER, F.G.S., "Stonycroft," Goodwood East—**Sir Joseph Verco Medal,** 1929; **Rep.-Governor,** 1901-22; **Council,** 1883-84, 1887-89, 1890-94, 1902-; **President,** 1894-96; **Vice-President,** 1884-87, 1889-90, 1896-1902; **Editor,** 1883-88, 1893-94, 1895-96, 1901-.
1928. HURCOMBE, Miss J. C., 95 Unley Road, New Parkside.
1928. IFOULD, PERCY, Kurralta, Burnside.
1918. *ISING, ERNEST H., c/o Superintendent's Office, S.A. Railways, Adelaide.
1918. *JENNISON, Rev. J. C., 7 Frew Street, Fullarton Estate.
1910. *JOHNSON, E. A., M.D., M.R.C.S., Town Hall, Adelaide.
1921. *JOHNSTON, PROFESSOR T. HARVEY, M.A., D.Sc., University, Adelaide—**Rep.-Governor,** 1927-29; **Council,** 1926-28; **Vice-President,** 1928-31, **President,** 1931 32.
1929. JOHNSTON, W. C, Government Agricultural Inspector, Riverton.
1920. *JONES, PROFESSOR F. WOOD, M.B., B.S., M.R.C.S., L.R.C.P., D.Sc., F.R.S., University, Melbourne—**Rep.-Governor,** 1922-27; **Council,** 1921-25; **President,** 1926-27; **Vice-President,** 1925-26.
1926. JULIUS, EDWARD, Conservator of Forests, Adelaide.
1918. KIMBER, W. J., 28 Second Avenue, Joslin.
1915. *LAURIE, D. F., Agricultural Department, Flinders Street, Adelaide.
1884. LENDON, A. A., M.D., M.R.C.S., 66 Brougham Place, North Adelaide.
1922. LENDON, GUY A., M.B., B.S., M.R.C.P., North Terrace.
1925. LEWIS, A., M.B., B.S., The Maudsley Hospital, Denmark Hill, London, S.E. 5.
1930. LOUWYCK, REV, N. H., The Rectory, Yankalilla.
1922. *MADIGAN, C. T., M.A. B.E., F.G.S., University of Adelaide—**Council,** 1930-.
1923. MARSHALL, J. C.. Darrock, Payneham.
1928. *MAEGRAITH, B. G., M.B., B.S., Magdalen College, Oxford, England.
1932. MANN, E. A., C/o Bank of Adelaide, Adelaide.
1929. MARTIN, F. C., B.A.. Technical High School, Thebarton.
1931. MARTIN, PROFESSOR SIR CHAS. J., Kt., C.M.G., D.Sc., University, Adelaide.

Date of Election.

1905. *MAWSON, SIR DOUGLAS, D.Sc., B.E., F.R.S., Professor of Geology, University, Adelaide **Sir Joseph Verco Medal,** 1931; **President,** 1924-25; **Vice-President,** 1923-24, 1925-26.
1919. MAYO, HELEN M., M.D., 47 Melbourne Street, North Adelaide.
1920. MAYO, HERBERT, LL.B., K.C., 16 Pirie Street, Adelaide.
1907. MELROSE, ROBERT T., Mount Pleasant.
1924. MESSENT, P. S., M.B., B.S., 192 North Terrace.
1930. MILLER, J. I., 18 Ralston Street, Largs Bay.
1925. †MITCHELL, Professor SIR WILLIAM, K.C.M.G., M.A., D.Sc., The University, Adelaide.
1930. MITCHELL, MISS U. H., B.Sc., Presbyterian Girls' College, Glen Osmond.
1897. *MORGAN, A. M., M.B., Ch.B., 215 Brougham Place, North Adelaide.
1924. MORISON, A. J., Deputy Town Clerk, Town Hall, Adelaide.
1930. MORRIS, L. G., Beehive Buildings, King William Street, Adelaide.
1921. MOULDEN, OWEN M., M.B., B.S., Unley Road, Unley.
1925. †MURRAY, HON. SIR GEORGE, K.C.M.G., B.A., LL.M., Magill, S.A.
1925. NORTH, Rev. WM. O., Methodist Manse, Netherby.
1930. OCKENDEN, G. P., 11 Ailsa Street, Fullarton Estate.
1932. OLIPHANT, H. R., University, Adelaide.
1913. *OSBORN, T. G. B., D.Sc., Professor of Botany, University, Sydney—**Council,** 1915-20, 1922-24; **President,** 1925-26; **Vice-President,** 1924-25, 1926-27.
1927. PALTRIDGE, T. B., B.Sc., Koonamore, via Waukaringa, S.A
1929. PANK, HAROLD G., 75 Rundle Street, Adelaide.
1929. PAULL, ALEC. G., B.A., B.Sc., 10 Milton Avenue, Fullarton Estate.
1924. PEARCE, C., Happy Valley Reservoir, O'Halloran Hill.
1927. PENNYCUICK, S. W., D.Sc., The University of Adelaide.
1924. PERKINS, A. J., Director of Agriculture, Flinders Street, Adelaide.
1928. PHIPPS, IVAN F., Ph.D., Waite Agricultural Research Institute, Glen Osmond.
1926. *PIPER, C. S., M.Sc., Waite Agricultural Research Institute, Glen Osmond.
1925. *PRESCOTT, PROFESSOR J. A., D.Sc., A.I.C., Waite Agricultural Research Institute, Glen Osmond—**Council,** 1927-30; **Vice-President,** 1930-32; **President,** 1932-.
1926. PRICE, A. GRENFELL, M.A., D.Sc., F.R.G.S., St. Mark's College, North Adelaide.
1907. †*PULLEINE, ROBERT H., M.B., Ch.M., North Terrace, Adelaide—**Council,** 1914-19, 1932-; **President,** 1922-24; **Vice-President,** 1912-14, 1919-22, 1924-25; **Secretary,** 1909-12, 1925-30.
1925. RICHARDSON, Professor A. E. V., M.A., D.Sc., "Urrbrae," Glen Osmond, S.A.
1926. *RIDDELL, P. D., Technical College, Newcastle, N.S.W.
1911. ROACH, B. S., 81 Kent Terrace, Kent Town—**Treasurer,** 1920-32.
1925. ROGERS, L. S., B.D.Sc., 192 North Terrace, Adelaide.
1905. *ROGERS, R. S., M.A., M.D., 52 Hutt Street, Adelaide—**Council,** 1907-14, 1919-21; **President,** 1921-22; **Vice-President,** 1914-19, 1922-24.
1931. RUDD, E. A., 10 Church Street, Highgate.
1922. *SAMUEL, GEOFFREY, M.Sc., University of Adelaide
1928 SCOTT, A. E., B.Sc., Waite Agricultural Research Institute, Glen Osmond.
1924. *SEGNIT, RALPH W., M.A., B.Sc., Assistant Government Geologist, Flinders Street, Adelaide—**Secretary,** 1930-.
1891. SELWAY, W. H., 14 Frederick Street, Gilberton—**Council,** 1893-1909.
1926. *SHEARD, HAROLD, Nuriootpa.
1928. SHOWELL, H., 27 Dutton Terrace, Medindie.
1920. SIMPSON, A. A., C.M.G., C.B.E., F.R.G.S., Lockwood Road, Burnside.
1924. SIMPSON, FRED. N., Dequetteville Terrace, Kent Town.
1925. †SMITH, T. E. BARR, B.A., 25 Currie Street, Adelaide.
1927. STAPLETON, P. S., Henley Beach, South Australia.
1922. SUTTON, J., Fullarton Road, Netherby.
1932. SWAN, D. C., B.Sc., Waite Agricultural Research Institute, Glen Osmond.
1925. SYMONS, IVOR G., Church Street, Highgate.
1929. *TAYLOR, JOHN K., B.A., M.Sc., Waite Agricutural Research Institute, Glen Osmond.
1929. TEE, SIDNEY F., Adelaide Hospital.
1923. *THOMAS, R. G., B.Sc., 5 Trinity Street, St. Peters, S.A.
1923. *TINDALE, N. B., South Australian Museum, Adelaide.
1894. *TURNER, A. JEFFERIS, M.D., F.E.S., Wickham Terrace, Brisbane, Queensland.
1925. TURNER, DUDLEY C., National Chambers, King William Street, Adelaide.
1878. *VERCO, SIR JOSEPH C., M.D., F.R.C.S., North Terrace, Adelaide—**Council,** 1924-; **President,** 1903-21; **Vice-President,** 1921-23.
1924. WALKER, W. D., M.B., B.S., B.Sc., c/o National Bank, King William Street.
1929. WALTERS, LANCE S., 157 Buxton Street, North Adelaide.
1912. *WARD, L. KEITH, B.A., B.E., D.Sc., Govt. Geologist, Flinders Street, Adelaide—**Council,** 1924-27; **President,** 1928-30; **Vice-President,** 1927-28.

Date of Election.

1920. Weidenbach, W. W., A.S.A.S.M., Department of Mines, Adelaide.
1930. Whitelaw, A. J., B.Sc., Norwood High School, Kensington.
1930. Wilkinson, Professor H. J., B.A., Ch.M., M.D., University, Adelaide.
1931. Wilson, Chas. E. C., M.B., B.S., "Woodfield," Fisher Street, Fullarton.
1920. *Wilton, Professor J. R., D.Sc., University of Adelaide.
1923. *Wood, J. G., M.Sc., University of Adelaide.
1931. *Woods, Miss N. H., M.A., Mount Torrens.

ASSOCIATE.

1929. Cleland, W. Paton, 31 Wattle Street, Fullarton.

PAST AND PRESENT OFFICERS OF THE SOCIETY.

PRESIDENTS.

1877-79 Prof. Ralph Tate, F.G.S., F.L.S.
1879-81 Chief Justice [Sir] S. J. Way.
1881-82 [Sir] Charles Todd, C.M.G., F.R.A.S.
1882-83 H. T. Whittell, M.A., M.D., F.R.M.S.
1883-84 Prof. H. Lamb, M.A., F.R.S.
1884-85 H. E. Mais, M.I.C.E.
1885-88 Prof. E. H. Rennie, M.A., D.Sc., F.C.S.
1888-89 [Sir] Edward C. Stirling, C.M.G., M.A., M.D. (Cantab.), F.R.C.S., F.R.S.
1889-91 Rev. Thomas Blackburn, B.A.
1891-94 Prof. Ralph Tate, F.G.S., F.L.S.
1894-96 Prof. Walter Howchin, F.G.S.
1896-99 W. L. Cleland, M.B.
1899-03 Prof. E. H. Rennie, M.A., D.Sc., F.C.S.
1903-21 Sir Joseph C. Verco, M.D., F.R.C.S.
1921-22 R. S. Rogers, M.A., M.D.
1922-24 R. H. Pulleine, M.B., Ch.M.
1924-25 Sir Douglas Mawson, D.Sc., B.E., F.R.S.
1925-26 Prof. T. G. B. Osborn, D.Sc.
1926-27 Prof. F. Wood Jones, M.B., B.S., M.R.C.S., L.R.C.P., D.Sc., F.R.S.
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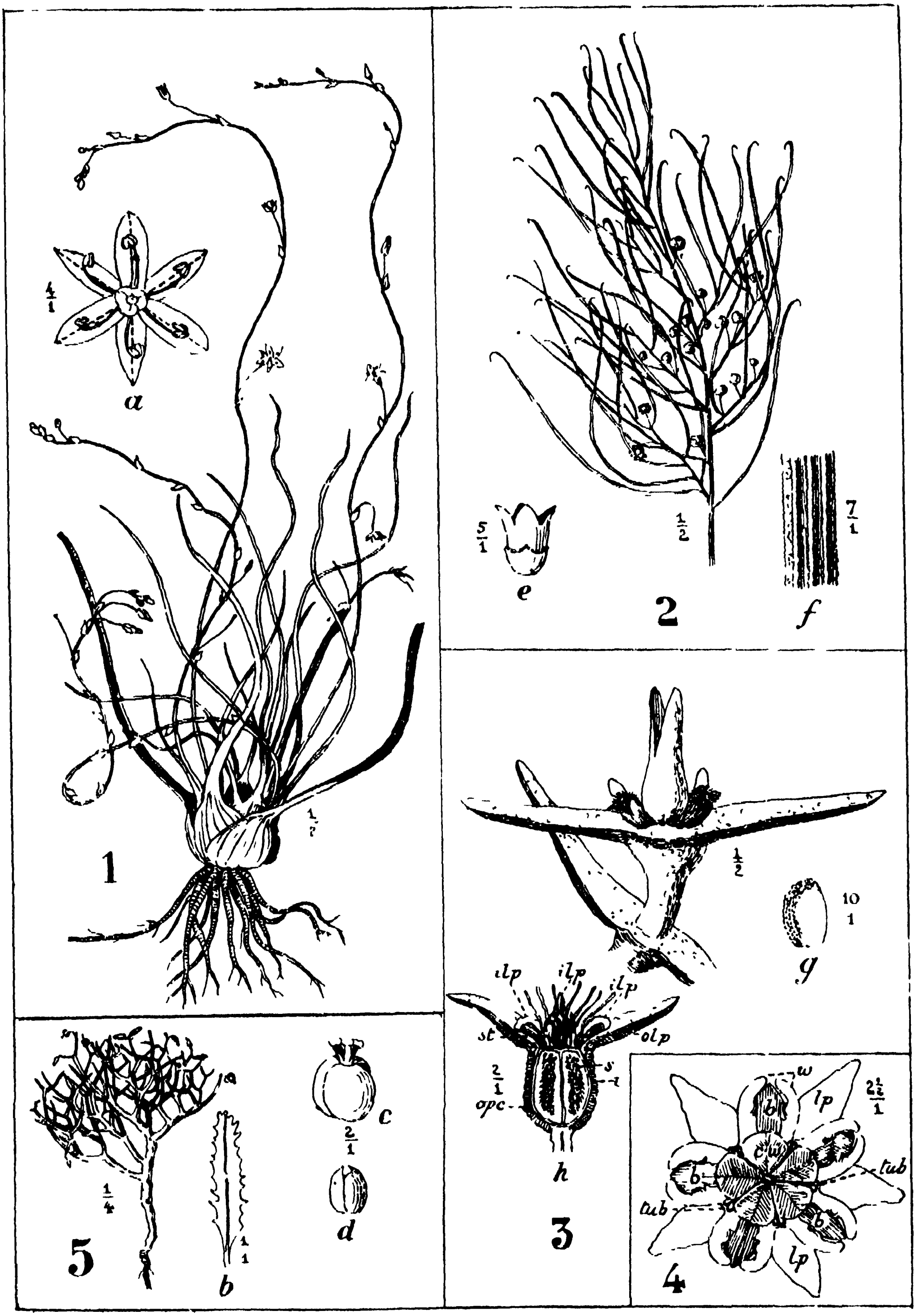
GENERAL INDEX.

[Generic and specific names in italics indicate that the forms described are new to science.]

PLATES I. to IX.



1. *Bulbine semibarbata* var. *depilata*. 2. *Acacia barattensis*. 3. *Carpobrotus Pulleinei* 4. *Disphyma australe*. 5. *Euphorbia Murrayana*

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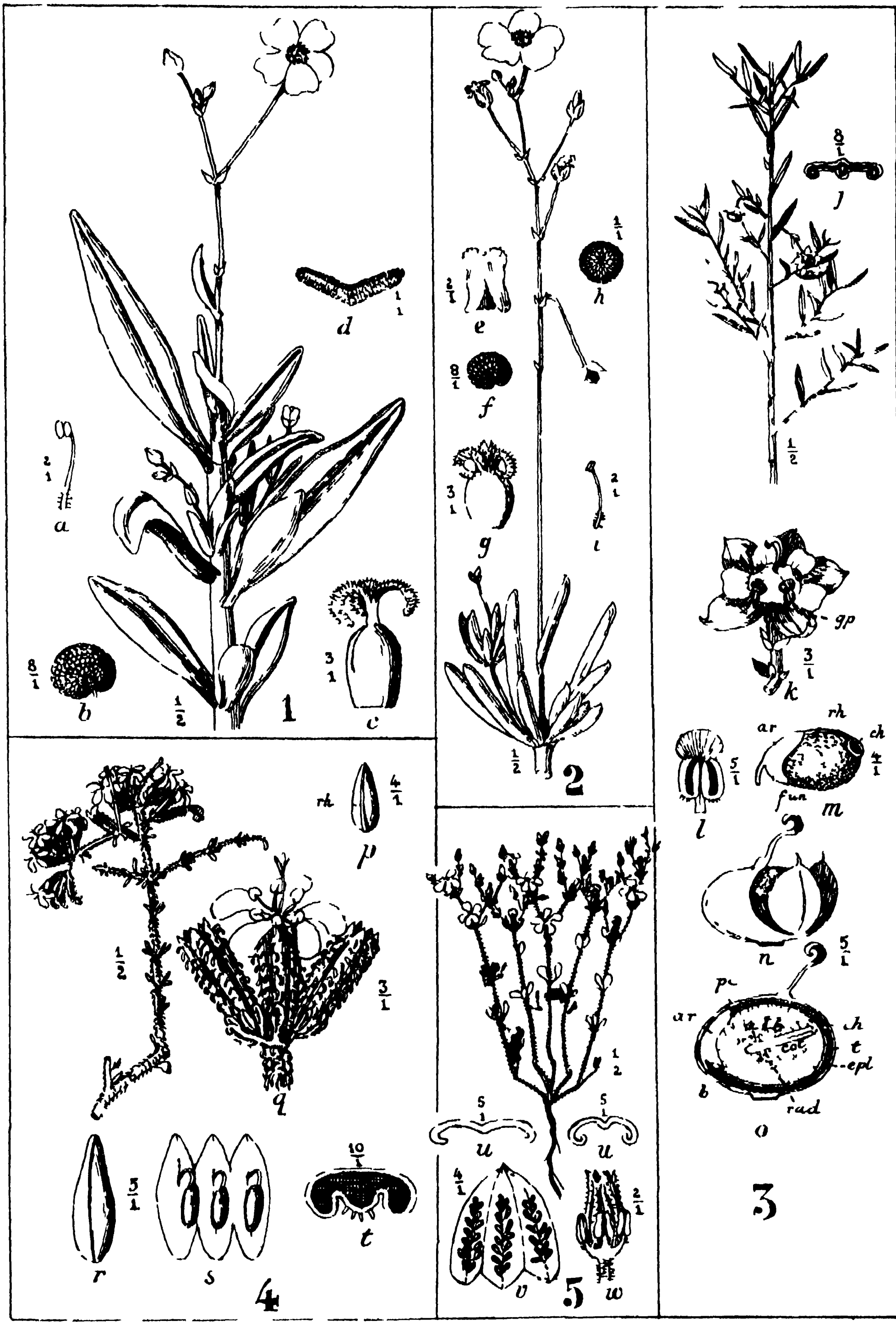

1 *Calandrinia kalumnensis* 2 *Calandrinia remota* 3 *Clelandia convallis*
4 *Frankenia crispa* 5 *Frankenia orthotricha*

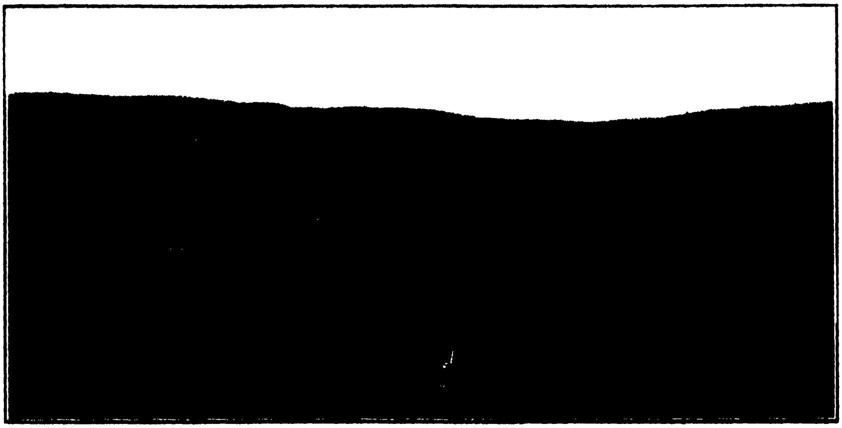

Fig. 1. Love's Creek Valley at Acacia Well.

Fig. 2. Pertaknurra Limestone in Bitter Springs Gorge

Fig. 3 Pertaknurra Quartzite plunging into Aruntan Gneiss at White Range Mines

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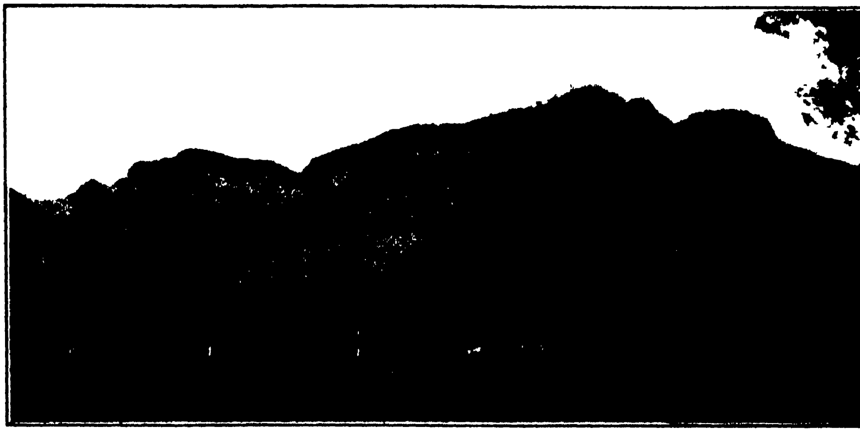

Fig. 1 Syncline in Larapintine Basal Beds on Ross River

Fig. 2 Pertatataka Limestone with North Dip Slope, River Ross

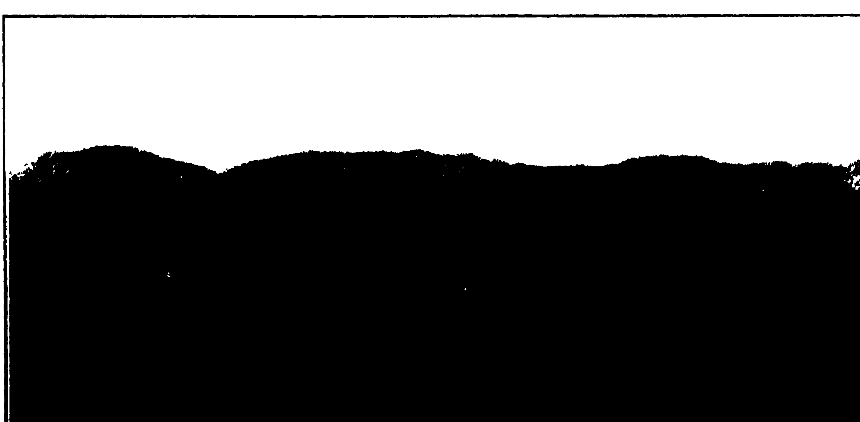

Fig. 3. The Northern Front of the Harts Ranges.

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Fig. 1. A Scoop-hole in the Entia Creek

Fig. 2. The Upper and Largest of the Oorobbra Rockholes

Fig. 3. Huckitta Station, from the edge of the Larapintine Tableland.

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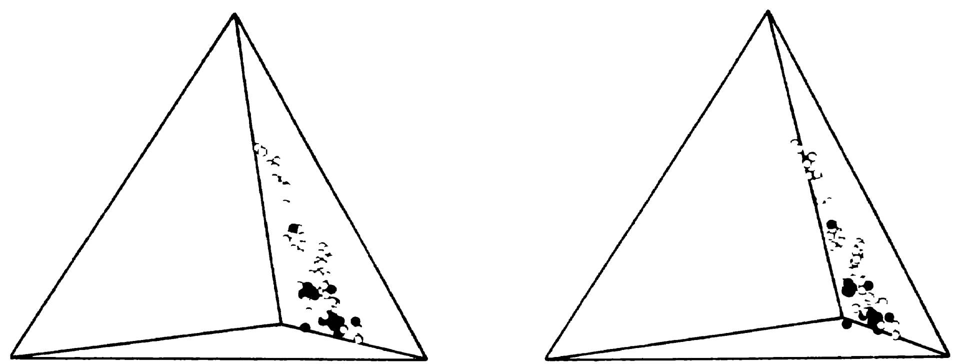
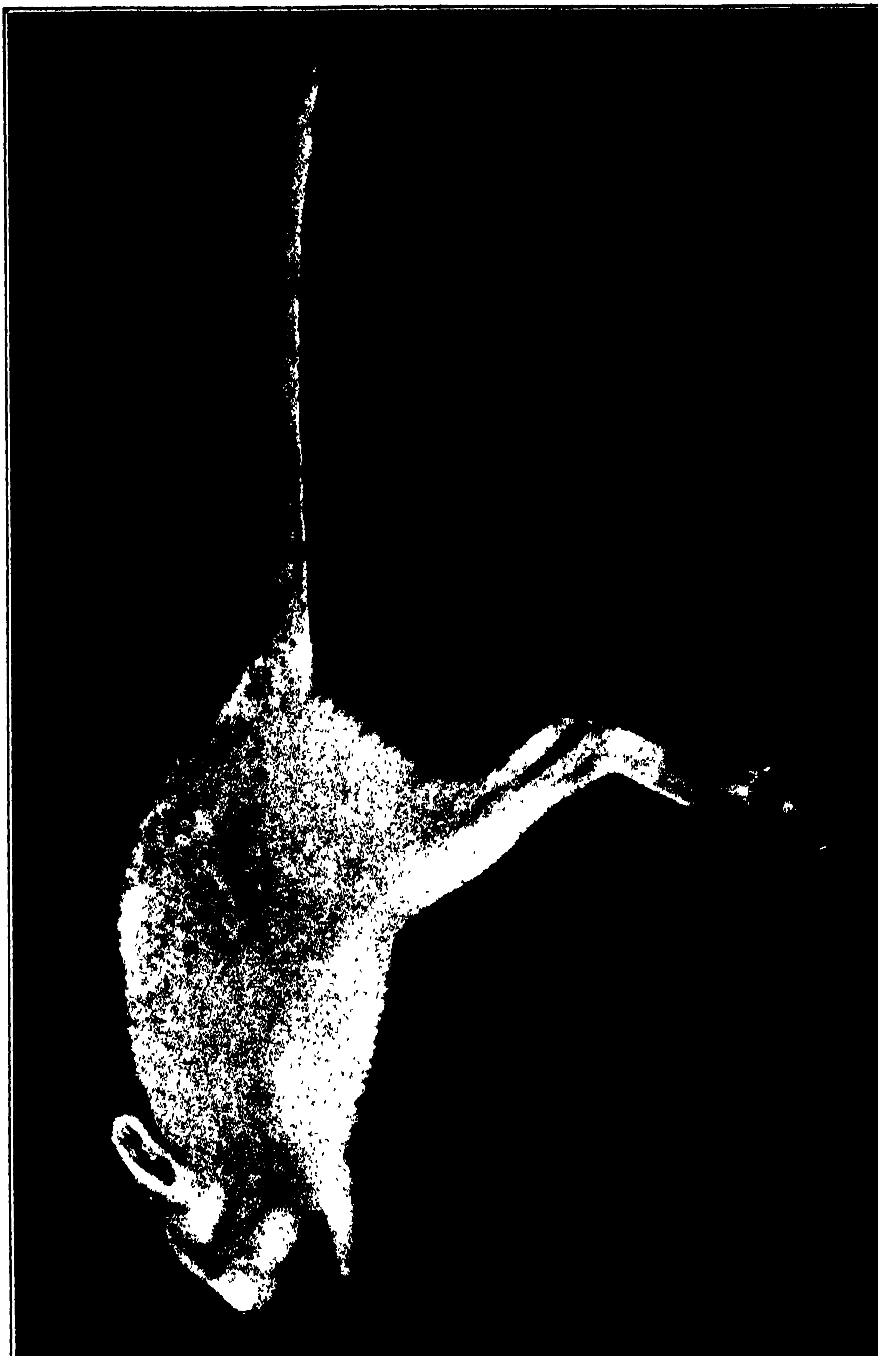


Stereoscopic pair of diagrams illustrating the plotting within a tetrahedron of the mechanical analyses of samples from the type profiles of mallee soils from South Australia



Caloprymnus campestris. General outline of subadult ♂.

Photo by H. H. Finlayson. Gillingham & Co. Limited, Printers, Adelaide

Fig. 1 *Calopymnus campestris*. Profile view of the head of an adult ♀

Fig. 2. Front view of adult ♀

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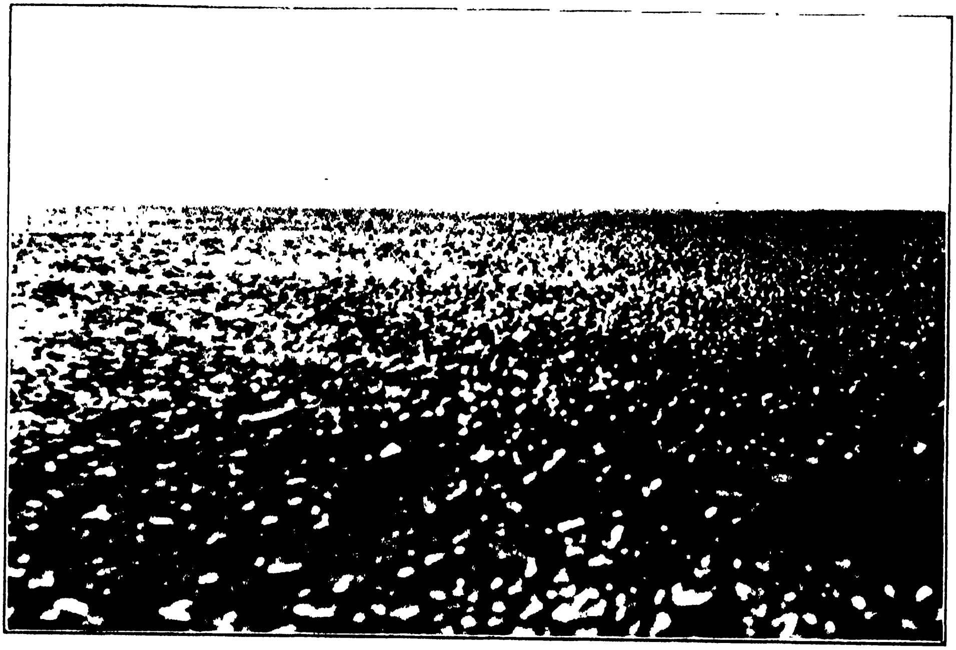

Fig. 1. The gibber plains. A view of Sturt's Stony Desert.

Fig. 2. A sandridge claypan unit, near Clifton Hills Station.

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